Africa RISING Project in Ethiopian Highlands Work Plans – 2017

Contents

Feed resources innovations–Scaling at farm and watershed level

Background and Justification

The feed resource base in the mixed farming system of the Ethiopian highlands has been on decline due to the continual conversion of grazing lands to arable lands and concomitant loss of fertility/land degradation on the remaining pasture lands. This has forced farmers to heavily rely on crop residues for their animals. Reports show that 40 - 80 % of the diet of ruminants are derived from crop residues particularly during the long dry period when green forage becomes scarce. Heavy reliance on crop residues for livestock nutrition has many implications on the livestock productivity and sustainability of the mixed farming system in the highlands. Nutritionally, crop residues have poor quality and when fed alone rarely fulfil the maintenance requirements of animals. Complete removal of residues from crop lands for livestock feeding contributes significantly to the gradual depletion of soil organic matter content, low water holding capacity and subsequent loss of soil fertility of arable lands. For a sustainable improvement in crop-livestock productivity, it is therefore imperative to improve the feed resource base of the mixed farming system in the highlands by introducing well-adapted and high yielding fodder crops and efficient utilization practices.

Although the livestock sub-sector contributes significantly (about 46%) to the agricultural GDP of Ethiopia, the productivity of the sub-sector has remained very low. Feed shortage (in terms of quantity and quality) has been one of the major reasons for the sub-optimal productivity of the livestock sub-sector. In its second growth and transformation plan (GTP II), the government has given special emphasis to the livestock subsector with the objective of adequately exploiting its potential for rural poverty reduction, food security, export earnings, and job creations for youth and women. Improving animal feed resources is one of the main strategies to realize these objectives together with breed improvements and better management of animal health issues.

Currently the government is also giving due emphasis to soil and water conservation works at watershed level throughout the country. Terraces have been built on sloppy areas to minimize soil erosion and improve water percolation/infiltration into cropping/grazing lands. These physical structures (terraces/soil bunds) need biological reinforcement to serve their purpose for extended periods and realize their benefits. Planting of multipurpose fodder trees and perennial grasses on these niches can create a synergy to protect the environment and at the same time increase the feed biomass available to improve livestock productivity. Thus, such integration of forage production in the cropping system has a potential to intensify the mixed farming system, while shaping it to be resilient to climatic shocks.

With the development of watersheds, regional administrations have started to develop policy directions and community bylaws aimed at promoting controlled grazing (as opposed to free grazing), improving livestock productivity per head of animal (through improved breed and nutrition) and reducing livestock herd sizes. To realize these policy directions step by step, it needs, among others, a long-term forage development plan to ensure adequate feed biomass availability that paves the way for the adoption of a sustainable cut-and-carry feeding system. In addition, it is important to equip farmers with the necessary

skills to feed livestock balanced rations (according to requirements) and avoid unnecessary wastage of feed biomass while feeding and during storage. Introduction of improved feeding troughs, feed conservation practices, and storage sheds contribute considerably to this end. Hand-on training, and easily understandable manuals for feed conservation, formulation and feeding for different classes of animals will help to save feed resources and maximize returns.

Forage markets are emerging in different parts of the country, and in some ILRL's research/intervention areas farmers started to increase their income from the sale of forage biomass, forage seedlings (cuttings/root splits), and forage seeds. In some sites (Jeldu and Diga, central Ethiopia) farmers have organized themselves in a forage (desho grass) producers' cooperative to sell their products in an organized manner. Farmers witnessed that by cutting and selling desho grass three times per year from soil bunds, they started to get a good amount of cash income for their family. Capitalizing on such success stories to diversify the income of farmers needs to be given attention in the second phase of the Africa RISING project.

Describe the nature of innovations to be scaled

This scaling partnership will take an integrated approach to promoting a portfolio of feed-related innovations that have been validated by Africa RISING. The aim will be to promote the adoption of these innovations, either individually or in combination, to meet the needs of the direct beneficiary households. They key interventions are:

1. *Supplementary forage from rain-fed/ irrigated oat–vetch mixtures:* The traditional feed resources with small scale crop-livestock highland farmers is crop residue harvested at total maturity of food crops characterised by low nutrient content and low-level digestibility of the feed. Pilot experiment during AR phase I proved that farmers who grew Oats-vetch mixtures with rains and irrigation on small plots of land could change their feed quality and quantity especially during feed shortage time (irrigation season) and their return from their livestock. Oat is a fast, upright growing annual grass that has a potential to produce significant forage biomass within two months of planting, reaching more than 1m height under good moisture conditions. The plant grows well in high and mid altitude areas of Ethiopia, where the soil is optimally drained and has a pH range of 5.0 – 6.5. It can also tolerate acidic soils as low as 4.5. Vetch is also an annual legume forage, which has a similar growing niche to that of oat forage. Growing oat-vetch mixture together (intercropped) has proved to be a suitable feed innovation because of a number of advantages. The intercropped oat-vetch forage produces high quality (energy and protein rich) and quantity forage that can be used as a supplement to locally available feed resources for ruminant livestock. In the Africa RISING research sites, the intercropped fodder has yielded 11 – 19 tons/ha DM under rain fed condition, with 15% crude protein and 9.5 MJ metabolizable energy/kg DM. The oat-vetch forage can be used as a good rotation crop in areas (like Bale, Ethiopia) where crop disease is a major problem due to several years of mono-cropping. As the vetch is a nitrogen fixing plant it can replenish the nitrogen content of the soil for the next round of crop cultivation. Supplementation of 1-2 kg DM oat-vetch mixture to dairy cows has a potential to give 1.5-2 lts of extra milk to farmers. Adoption of this feed innovation at a larger scale is therefore expected to boost livestock productivity and improve the livelihood of smallholders.

2. *Fodder from tree Lucerne:* Tree Lucerne is a fodder and soil fertilizer leguminous tree that grows well in highland areas of Ethiopia on well drained soils. Under good management (fencing, manuring and watering), the seedlings of tree Lucerne can reach up to 2 m of height within a year time and be ready for the first forage cut within 9 months of planting. The leaf and edible branches of tree Lucerne are very good sources of nutrients for ruminant livestock, containing high amounts of crude protein, app 20-25% and digestible organic matter, app 70%. The foliage of this fodder can be fed green or preserved in the form of hay and used as needed. Findings from the Africa RISING sites indicate that a cutting height of 1.5m gives better fodder biomass yield (up to 7 t/ha dry biomass) for tree Lucerne under farmers management condition. Depending on rainfall patterns and growing niche, the fodder may be harvested in 3-6 months interval. Previous trials indicate that cattle prefer the hay, whereas sheep and goats readily consume the green fodder. In addition to its role as a high quality feed resource, the plant improves soil fertility by fixing nitrogen and produces biomass that can be used for mulching and green manuring. It does not compete with other crops, and thus is suitable for strip cropping or for natural resource management by planting it on soil bunds. The tree also produces considerable amount of wood biomass for use as fuelwood. All these features make this tree an ideal agroforestry plant in the highlands of Ethiopia, where availability of leguminous fodder trees are limited. Therefore, integration of tree Lucerne in the cropping system helps to intensify the crop-livestock system, reduce vulnerability to climatic shocks and improve biodiversity in the highlands.

3. *Sweet lupine as a feed and food crop*: Highlands of Ethiopia suffer from shortage of land to allocate for food and feed differently. Intervention with dual/multipurpose crops like sweet lupine, a leguminous food and feed crop that can be grown in well drained soils (non-Vertisols) in the highlands of Ethiopia, has been proved to cater diverse needs of the farmer at the same time. Adaptation experiment with 4 varieties of sweet lupine has been carried out in the AR sites during phase I of the project. Varieties best adapted have been identified for further testing with wider community. The grain has high crude protein content (37%) for use as food and concentrate supplement to livestock. Adaptation trials in the Africa RISING sites showed that it can produce as high as 2.6 t/ha of grain, in addition to the crop residue biomass (3.8 t/ha) it produces. Currently, there is a widespread disease problem with faba bean and field pea crops. Inclusion of sweet lupine in the cropping system therefore helps to break disease cycles and offer alternative pulse grain for different purposes. This study aims to measure the total benefits (food, feed, soil nutrient) obtained from the intervention of sweet Lupine by farmers with smaller land areas in the four sites of the project.

4. *Desho grass for feed and land stabilization*: Watershed management (soil and water conservation) and area closure are some of the mega projects initiated by the Ethiopian government as a means to reduce soil erosion and environmental degradation. The physical interventions alone (soil bunds or terraces) however are observed to contribute little if not accompanied by biological treatments like planting of grasses, legumes, trees on the bunds. The initial biological treatments on micro watershed development in two of the AR sites indicate that the intervention has to be scaled to address the SWC agenda. These structures (soil bunds) have become important niches to grow forage for livestock and generate additional benefit on top of minimizing soil erosion and improving infiltration. The grass biomass is also useful to compensate for the amount of land farmers loose due to physical structures on their crop lands as the grasses are planted on the bund. Desho grass has become an effective indigenous grass that grows well on soil bunds. It stabilizes the soil bund through its root system,

thereby prolonging the life of the soil bunds. The grass has also good nutritional quality (about 11% crude protein) and can be harvested 3-4 times per year depending on availability of rainfall and produce 4-5.5 ton DM/ha. Desho grass can easily be propagated using root splits with almost hundred percent survival rate in the highlands. Therefore, scaling this feed innovation is useful both to protect the environment and improve livestock productivity and generate additional income for smallholders.

5. *Intercropping forages with faba bean*: Farmers in Ethiopian highlands depend on crop thinning and weed outs from crop fields for feeding their livestock during the crop growth season when stored feed stock is depleted and most of the arable lands are covered with crops. Intercropping cultivated/improved forages with food crops like faba bean showed that farmers can harvest quality forage from their crop fields during critical feed shortage time while maintaining the balance between grain and fodder. In the Africa RISING sites, field trials showed that when oat forage is intercropped with faba bean, it is possible to obtain about 2.6 tons of good quality forage DM/ha (10% CP) without significantly affecting the grain yield of the faba bean. Economic analysis of this practice also showed that intercropping indeed improves whole plot productivity. This intervention therefore intends to measure at a wider scale the total benefit (food, feed) farmers can obtain from their limited land if they intercrop faba bean with forages, where crops and livestock are equally important for the community.

6. *Alfalfa forage and seeds*: Intensive small-scale irrigation for high-value crops is one of the initiatives by the Ethiopian government for small scale farmers. Improved forage seed sources are very scarce for the growing demand for quality livestock feed (currently price of alfalfa seed stands at 500-800ETB/kg). Growing high-value forages like alfalfa is expected to offer substantial income from small area of land that can be developed at backyards. With good management (manuring and irrigation) alfalfa in 4-5 weeks interval and produces 7-10 tons DM/ha forage containing 20-24% crude protein. It contains high calcium content and provides more calcium per hectare than any other forage, making it an ideal supplement for dairy cows and poultry. Therefore, alfalfa forage is believed to contribute significantly to home garden intensification by producing high quality protein supplement for poultry and dairy production, improving livestock productivity, income and nutrition of households. This study aims to measure the changes in household nutrition and income as a result of growing alfalfa for forage and seed by a wider community using both rain fed and irrigation agriculture.

7. *Improved feed troughs and storage structures:* Proper utilization of available feed resources is one of the ways to cope with feed shortages. In the AR research sites, it has been observed that wooden feed troughs and feed storage sheds reduce feed wastage during utilization and storage by about 30–50%. Farmers were also able to minimize the labour demand for feeding and taking care of animals when animals are tethered and offered feed on feeding troughs. Construction of feeding troughs for different classes of animals is therefore important to implement a sustainable cut-and-carry feeding system in the highlands, particularly at this time when free movement of animals has been limited due to local bylaws restricting free grazing.

8. *Ration formulation based on nutritional composition of feeds* Farmers need technical assistance and guidance on the optimal utilization of cultivated fodders together with locally available feed resources

(including crop residues) and agro-industrial by-products. In the Africa RISING research sites, guidelines for mixing crop residues with oat-vetch mixtures and tree Lucerne leaf have been developed to improve the utilization of available feed resources and increase livestock productivity. This utilization guideline will further be enriched and scaled in areas where farmers adopt improved fodder cultivation. Moreover, with the expansion of agro-industries in the country, it is expected that by-products will contribute significantly to fulfilling the energy and protein demands of livestock. Proper use of such products in formulating balanced rations will be promoted. Through this intervention it is therefore aimed to provide training to farmers, recommend optimal rations (based on the available resources) and work with national partners to develop the value chain for livestock feed resources so that farmers can easily access them at reasonable prices. Optimal mixing proportion and daily rates have been developed to efficiently use for maximum benefit.

Benefits

What benefits are anticipated from the widespread uptake of these innovations?

- Improved food security:

9. The widespread adoption of the above innovations will increase the quality and quality of feed biomass available for livestock, which in turn positively impact the productivity of livestock (milk & meat production). This will have a direct benefit in terms of improved food security, as families will have better access to foods of animal origin and cash income to buy other family needs. Livestock are the main source of farm power, and increased feed biomass availability will have a positive impact on crop cultivation as a result of the improved work performance of well-fed draught oxen

- Increased household income and contribution to the national economy:
  The innovations have a potential to increase and diversify the income of smallholders through sale of fattening animals, livestock products and services, as well as forage seeds and biomass. The contribution of the livestock sub-sector to the national economy will increase accordingly

- Environmental benefits:

10. Integration of fodder development at farm and watershed level has a number of environmental benefits including control of soil erosion, water conservation, and carbon sequestration

- Gender:

11. The workload on women and children searching for forage and herding animals will reduce upon successful adoption of these innovations. Women would benefit from increased access to cash income from dairy and small ruminant productions, while youth may get more time to concentrate on their education/go to school

- Nutrition:

12. Consumption of livestock products (meat, milk and egg) is likely to increase with improved livestock production, and that contributes significantly to the nutrition security of communities (particularly pregnant women and children)

- Biodiversity:

13. The biodiversity at watershed level will improve as a result of integration of legume and grass forages, and control of grazing animals. Soil and water conservation structures reinforced with forages will enable regeneration of the biodiversity

Research Questions

Specify the research questions that will backstop the partnership. It is accepted that these might evolve over the lifespan of the partnership.

1. How adoption and impact of feed resources innovations vary across farm household types?
2. What are the issues that create differences on the performance and adoption of feed resources innovations along the watershed/landscape gradients (up, mid and downstream)?
3. What would be the contribution of feed resources innovations to government farm and watershed level development initiatives?
4. What would be the economic, social and biophysical roles/impacts of feed resources innovations on the entire landscape/watersheds?
5. What roles can the social structures/platforms play in relation to adoption and scaling of feed resources innovations?
6. What attitudinal changes would evolve while farm households and communities adopt feed resources innovations?
7. How market orientation could affect adoption and impacts of feed resources innovations?
8. Which feed innovations work where and why?
9. What are the gaps and barriers for wider scaling of feed resources innovations?

Development Partnerships

List the partners who will be active, describe the contribution that they will make and how Africa RISING will support / backstop this with the research proposed. Also consider the comparative advantage offered by your partnerships. Make sure that you carefully consider roles and responsibilities of all partners.

We have a number of development partners who are committed to scaling some of the innovations described in the technologies description section.

- The southern Tigray zonal office and the extension in Endamehoni woreda, are scaling feed troughs and oat–vetch mixtures to similar kebeles and woredas within the zone. These activities will be expanded under this scaling initiative. In addition, Relief Society of Tigray (REST), a local NGO, is committed to scale out feed resources innovations such as oat-vetch for sheep fattening and feed trough in Endamehoni woreda.
- Farmers, zonal and woreda extension in Hadiya-Lemo, north Shewa-Basona, and Bale-Sinana are demanding the oat-vetch, tree Lucerne, feed trough and storage innovations for implementation.
- At local level, AGP works closely with the government extension system and supports their development initiatives both technically and financially. Joint planning with AGP will increase the resources available to this scaling initiative with a focus, particularly on the Feed the Future zones of influence. AGP focal persons are already members of the innovation platforms in Sinana, Basona and Endamehoni Africa RISING sites.
- A number of NGO partners are expressing interest in these technologies and are, in principle, considering integrating them into their programs; Inter Aide France and Catholic Relief Services (Wolaita, Kambatta and Hadiya zones).

- GIZ has expressed interest in tree Lucerne and other forage innovations for scaling at farm and watershed levels in Amhara, Oromia, SNNP and Tigray regions. These technologies are considered to be complementary to their efforts in sustainable land management for soil and water conservation.

Impact Pathway

Ensure that the contribution to FtF goals (e.g. improved food security, better health and nutrition, inclusive agriculture sector growth) are stated

Table 1. Impact pathways

Activities	Outputs	Outcome	Impact
Clustering niches and households	Report – Niche/household/innovation matching	Innovations appropriately placed and adopted	Food security and nutrition, income diversification, sustainable NR through improved feed resources utilization
Establish local forage seed and fodder trees seedling system	Private, cooperative/unions, government seed and seedling suppliers established	Accessibility to forage seeds and fodder trees seedlings improved	
Capacity building (training, visits)	Different scaling partners acquired knowledge and skill	Efficient implementation of innovations	
Input-output market linkage	Existing and potential markets identified and linked	Sustainable market access	
M&E	Number of households adopting the different feed resource innovations	Higher livestock productivity; improved rural livelihoods (e.g., through income from livestock and animal by-product as well as sale of animal fodder); agricultural labor savings (e.g., female, community, child due to reduced time spent on taking care of animals); reduced loss of animal feed due to improved storage facilities; improved dietary quality (e.g., through the consumption of nutrient-dense animal source foods and legumes such as sweet lupine); improved soil fertility	

Targets / Zone of Influence

How many potential beneficiaries are out there? How many do you hope to materially impact on? Where are they?

The feed resources innovations will be initially scaled (horizontally and vertically) in four zones with the aim of implementing in 51 woredas (793 kebeles). The rural population in Ethiopia is estimated to be over 71 million of which around 16.5 million are livestock keepers. The beneficiary calculations in the table below are on the scope of engagement for this initiative in relation to the total rural population and numbers of livestock keepers.

Table 2. Targeted and potential beneficiary households for feed resources innovations.

Region / zone	Woredas / kebeles	Directly engaged households	Potential beneficiaries in ZoI
Amhara / North Shewa	22 / 300	54,066	233,136
Oromia / Bale	15 / 164	24,586	106,018
SNNPR / Hadiya	9 / 273	32,652	140,795
Tigray / South Tigray	5 / 56	19,920	85,896
Total		131,224	565,845

Arrangements Required for Monitoring and Evaluation

How will you generate and present the evidence that your partnership has been successful?

To gauging progress with regard to achieving project targets, AR-EH researchers will jointly (with IFPRI's M&E team, development partners, the local M&E coordinator to be hired) implement various M&E-related activities that can be classified into two.

- *Process evaluations:* activities under these categories are aimed at better understanding the implementation of the scaling-up activities and gauge progress towards achieving the quantifiable targets of beneficiaries (summarized in Table 2) and the various implementation strategies. While a process evaluation is typically done at the end of the project (in 2021), yearly process evaluations will be conducted to generate evidence that can feed into scaling up efforts in sub-sequent years (e.g., challenges faced, and lessons learned from the different partnerships). These evaluations will be done through exploratory studies, focus groups (with site coordinators, development partners, community leaders, and beneficiary farmers) and through reviewing of project documentations, etc. Evaluation results will be shared with AR EH researchers and other relevant stakeholders during review and planning meetings to help with better planning of activities in subsequent years.
- *Outcome and impact evaluations*: These evaluations are aimed at measuring how the adoption of feed resource innovations are impacting the various socio-economic and environmental outcomes (listed in Table 2) and generate evidence on the longer-term and

deeper changes attributed to the feed resource innovations. These evaluations will complement process evaluation by generating evidence on how AR EH project might affect lives and livelihoods on a broader scale and the generalizability of findings to smallholders within the ZoI and beyond (as summarized in the last column in Table 2). These evaluations are especially necessary to adequately answer research questions 4, 6, 7, 8 above. The main elements of these evaluations include the following:

  - Identification of different socioeconomic and bio-physical indicators guided by the Sustainable Intensification Indicators Framework (SIIF).
  - Development/adaptation/implementation of appropriate quantitative and qualitative data collection plan (e.g., sampling, data collection tools, data collection frequency, responsibilities, etc.)
  - Data analyses using quantitative and qualitative techniques
- Different platforms or fora for cross learning and evaluation will be organized to discuss M&E issues and share findings thereof.

Communications and Knowledge Management / Transfer

What arrangements will you put in place to communicate your activities and their benefits? What knowledge specific products and activities will you need to implement to support this?

- Media (Radio, TV), field days, visit, workshops, knowledge centers /FTC, share fair
- Fact sheet, digital stories, posters, journals, blogs, reports, briefs.

Gender

The feed resources technologies/innovations are gender sensitive and can benefit men, women, youth and other social categories. For instance, the feed trough technology in addition to saving resources helps to save family labour. Children and women in most rural areas of Ethiopia spend much time to attend and feed dairy cows, draft animals and small ruminants. They also perform a variety of tasks, including cleaning animals' stalls, compost manure, and are responsible for the breeding and tending to the health of smaller animals. Technologies that require less family labour encourage particularly children and young girls to go to school. The feed resources innovations are also equally important for all social categories to generate or diversify income, solve food insecurity problems and improve nutrition. Improved feed resources enhance productivity of livestock and contribute significantly to reduce malnutrition. In recent years, the livestock sector including feed and forages production and processing has become important sources of employment for the youth and women. Hence, the feed resources innovations that this project promotes can benefit all groups of farmers in various aspects.

Capacity building

This project will give emphasis on capacity building for human resources development and strengthening local partner organizations in a range of ways, all of which are designed to respond to demand from all of our development partners. The project also focuses on short-term and long-term trainings, experience sharing visits and regular meetings/workshops to speed up wider scaling. Need assessment on capacity development for each of the scalable technology's management and utilization is underway in Africa RISING sites and other potential areas. Demonstrations of some scalable technologies will be organized for farmers and extension experts on-site and off-site depending on circumstances. The capacity building component (training, demonstration), provision of starter seeds for some technologies and backstopping research will be a contribution of the project to show commitment to the development partners.

Budget break down

The budget breakdown covers the period from April 2017-March 2018.

Budget item	**Total budget (USD $)**
SALARIES	
TRAVEL AND TRANSPORTATION	20,000
OPERATIONAL COST	80,000
Training on tech management and utilization	40,000
Purchase of starter seed for some technologies	12,000
Demonstration of feed trough and shed in new areas	8,000
Backstopping research and R4D	20,000
TOTAL	100,000
INDIRECT COSTS	
TOTAL BUDGET	

Scaling up/out of improved cereals, and food legumes technologies for food security, incomes and feed in mixed farming areas of central, northern and South-eastern highlands of Ethiopia

Background and Justification

Agriculture is the most important sector of the economy and accounts for about 45% of the GDP, 90% of exports and 85% of employment. Human food and nutrition as well as livestock, nevertheless, remains key challenges to the Government of Ethiopia (GoE). The highlands of Ethiopia (>1500 meter above sea level) cover over 40% of the country's total land area and are home to over 80% of the total human and cattle populations. The production system predominantly mixed farming with cereals (wheat and barley), high land food legume and sheep are key components of the system. The livelihoods of the smallholder farmers rely on the production of barley (food and malt barley), high land food legumes (faba bean, field pea, lentil and grass pea) and sheep rearing (Table 1).

Cereals and high land food legumes are produced during the main (meher) and small (belg) rainy seasons. The small rainy season (rain fed and irrigated) covers 4% of the cultivated areas in the country. The production of barley, faba bean, lentil and field pea during the small rainy season helps small holder farmers to bridge the 3-4 months (June-September) food and feed gaps until the main season harvest is available. Wheat and barley are important crops for food and income generation for poor farmers, especially in women-headed households. Besides sources of food and nutrition, high land food legumes and malt barley are sources of incomes and feed to animals. The legume component improves system productivity through nitrogen fixation, serving as a break for insect pests, weeds and disease cycles affecting wheat, barley and potato. The highlands are characterized by high livestock densities of low productivity.

Livestock are kept by the majority of smallholder households for a variety of uses including provision of draft power, storage of capital, supply of manure as well as saleable products such as milk and meat. The feed resources have historically come from common rangeland resources, but with population increases and subsequent pressure on land, crop residues (CR) have increasingly become an important component of livestock diets. However, poor quality CR diets and severe feed shortages especially during dry seasons constrain the productivity needed to meet projected demand for livestock products. The nutritive value of CR from cereals and food legumes can be improved through varietal selections. Brewery by-products of malt barley emanating from beer factories present opportunities for supplementation to deal with nitrogen deficits in ruminant diets, so increasing the efficiency of use of poor-quality diet components.

Describe the nature of innovations to be scaled

Barley, durum wheat and food legumes

The innovation to be scaled out will be crop cultivars with their associated production packages evaluated and selected by male and female farmers, agro-industries and researchers at the four AR sites during

Phase-I (Table 1). Kabuli chickpea released from ICARDA public goods were evaluated in five districts in Quick-Pulse Phase I and two cultivars (Habru and Arerti) were selected by male and female farmers in Bale Zone. Lentil was also tested in Quick pulse in Sinana and in 2015/16 cropping season in all AR sites. The target crops will help to diversify the wheat-based cropping system of the highlands and reduce risks of climate variability and wheat rusts, grass weeds and the emerging faba bean diseases.

The inclusion of malt barley and durum wheat will help farmers to engage in producing high quality raw materials for the agro-industries and get better incomes that will be translated to improved livelihoods. The crop scaling will be supported by innovative seed delivery system, knowledge and skills achieved so far. The introduction and adoption of high yielding food legumes, barley and durum wheat have important dimension since they are highly palatable by animals and farmers are ready to compromise for some lower yield than bread wheat. However, the cultivars selected during Phase-I are high yielder than bread wheat and economical that off-set the yield difference to grow in diversification and/or rotation. The re-introduction of the traditional food legumes in mono-cropped wheat belts will help to break herbicide resistant grass weeds mainly in Arsi and Bale wheat belts. This scaling phase will include small rainy season in bimodal rainfall areas of Bale, North Shoa, Tigray and South Wollo using early maturing food barley, lentil and faba bean cultivars selected in North shoa and Sinana sites. The scaling out activities in this proposal will utilize other outputs from Phase-I protocols like fertilizer recommendations using blended fertilizers. Other technologies from ICARDA projects will be scaled out like integrated parasitic weed management on faba bean in Tigray and uses of rhizobium inoculants on faba bean and chickpea by linking with Menagesha Biotech Industry (MBI) PLC, a private sector that produce inoculants. There is a close collaboration between ICARDA and MBI.

Table 1. Cereal and high land food legume technologies for scaling in Phase II-*Meher season*.

SN	Crop/ technology	Maichew	Lemo	Basonaworana	Sinana	Leading CG-centre
1	Food barley	HB1307	HB1307	Cr.41/98 and Agegnehu	Abdene HB1307	ICARDA
2	Malt barley	Bekoji-1	Bekoji-1	Bekoji-1	Bahati, Bekoji-1, Traveler	ICARDA
3	Faba bean	Dosha	Tumsa	Dosha	Gebelcho and Dosha	ICARDA
4	Durum wheat	Mangudo	Ginchi	Utuba	Utuba	ICARDA
5	Lentil	Alemaya		Derash	Derash, Alem Tena	ICARDA
6	Field pea	Gume	Bilalo	Bilalo Burkitu	Burkitu	ICARDA
7	Kabuli chickpea	Arerti and Habru	Arerti and Habru	Arerti and Habru	Arerti and Habru	ICARDA
8	Bio-fertilizers**	Faba bean and chickpea	Faba bean and chickpea	Faba bean and chickpea	Faba bean and chickpea	ICARDA
9	Pulse beetle management	All legumes	All legumes	All legume crops	All legume crops	ICARDA

SN	Crop/ technology	Maichew	Lemo	Basonaworana	Sinana	Leading CG-centre
10	Integrated Parasitic weed management***	Faba bean				ICARDA

*Crop varieties and technology identified by farmers, researchers and the industry from Phase I for scaling in Phase II in Africa RISING sites and other similar Agro-Ecologies re summarized in this table.

**The Rhizobium isolates for chickpea and faba bean are tested by USAID funded projects and will be linked with Phase-II

***Package is developed with ICARDA bilateral project and ready to be scaled and can be linked with USAID funded project on faba bean and malt barley being implanted in Tigray.

****Scaling out of these technologies will also be aligned with USAID funded project has ongoing activities in the highlands of Amhara, Oromia, SNNPR and Tigray regions.

Table 2. Cereal and highland food legume technologies for scaling in Phase II-Belg season.

SN	Crop/technology	Basona worana	Sinana	Leading CG-center
1	Food barley	Agegnehu	Abdene, HB1307	ICARDA
2	Faba bean	Dosha	Gebelcho and Dosha	ICARDA
3	Lentil	Derash	Derash, Alem Tena	ICARDA
4	Field pea	Bilalo Burkitu	Burkitu	ICARDA
5	Kabuli chickpea	NA	Arerti and Habru	ICARDA

Benefits

The benefits of the project will be:

- Economic and financial benefits: These will be sufficiently attractive to drive expansion and sustain the initiative in medium to long term. Crops such as malt barley and durum wheat are industrial crops and breweries, malt factories as well as food factories currently tend to source their raw materials locally. This assured market is of benefit to local farmers. Legumes and sheep are integral components of the mixed farming systems in the highlands where high production of straw will benefit the livestock productivity through availability of feed during dry seasons as well as for sheep fattening. Moreover, farmers who will be producing seeds and adoption of high productive cultivars will benefit during the project period which is more or less medium-term period.
- Smallholder farmers (male and female) will benefit from increased productivity for food, reduction of cost of production, increase in incomes and dietary diversification and absorb shocks due to drought or any climatic/weather extremes as a result of asset building
- Farmers, extension staff and researchers' knowledge/skills improved during the implementation of the project

- Incorporation of barley and food legume varieties with food-feed traits to benefit enhanced grain production and straw feed quality
- Seeds of barley and food legumes will be easily available and seed growers will benefit from seed sales
- Enhanced nutritive value of available feed for sheep that will increase sales profits
- The increased incomes will benefit farmers by improving their quality of life (send their children to school; get better clothing, diet, housing and medical services)
- The project will create good linkages among stakeholders in the project areas to promote new technologies, knowledge/information and skills

Research Questions

- Some of the core research questions that the project will address include:
- What strategies are most effective for improving access to and capacity to use agronomic, feeding options, post–harvest storage, markets and other information by smallholder farmers especially women and youth to achieve sustainable intensification?
- How do smallholder farmers manage the trade-offs between production, sustainability and other socio-economic and environmental factors?
- What are the key risk factors for smallholders in participating in sustainable agricultural intensification and what risk management strategies can be put in place to manage them?
- What kind of approach is key to scale out technologies? Are innovative local seed delivery systems profitable and sustainable?
- Will legalization of seed cooperatives help famers to produce quality declared seed? What are the comparative advantage and marginal returns of it?

Development Partnerships

To bring greater and sustainable impacts through narrowing the yield, knowledge and skill gaps, joint efforts of key stakeholders are critical. The key partners in the implementation of crop technology in Phase II of AR are presented are in table 2.

Table 3. Implementing partners by core competencies

Partners	Contribution	Supports	Comparative Advantage
CGIAR	ICARDA: Barley, durum wheat, cool-season food legumes, soil, water and animal feed technologies, seed system, socio-economics ILRI-AR-Supports from AR site staff	Financial Technical support at AR sites	ICARDA: Research experiences and available technologies on malt and food barley, food legumes, and small ruminants Multidisciplinary research team for Sub Saharan Africa Research Platform Long standing successful partnership over 30 years with

Partners	Contribution	Supports	Comparative Advantage
			development partners and farmers in Ethiopian Highlands Informal seed system for barley and food legumes Rhizobium Research and Development Outstanding partnership with MoA, EIAR NGOs, AGP, ATA, and private companies in Ethiopia
Agro Industries	Potential buyers of grain and sellers of animal feed	Technical supports Linking their technology transfer activities with AR	Strategically located
EIAR and RARIs	Research and technology backstopping, coordination of field activities, data collections; organizing field days, provision of seeds of selected cultivars	Backstopping, implementing scaling, capacity building	Source of technologies, knowledge and information
MoAN, BoA	Extension service, mobilization of farmers, engage in data collections, field days	Capacity building	Farmer information, extension
Agricultural Transformation Agency	Capacity building, Knowledge transfer	Stakeholders capacity building and information	Knowledge transfer
Universities	Research backstopping /technology	Capacity building	Research, source of technologies
NGOs	Capacity building	Proven technology and information, training	Financial resource, target specific areas
Cooperatives and unions/	Technology multiplication, input supply, output market and credit access	Capacity building	Common interest groups
Agro dealers and traders	Input and output marketing	Capacity building	Input access
Seed enterprises	Seed supply	Technical support	Input access

Partners	Contribution	Supports	Comparative Advantage
Sheep multiplication centres	Technology multiplication	Financial support/capacity building	Source of improved breeds

EIAR: Ethiopian Institute of Agricultural Research, RARI: Regional Agricultural Research Institutes, MoANR: Ministry of Agriculture and Natural Resource, BoA: Bureau of Agriculture

Technologies to be scaled and Approaches

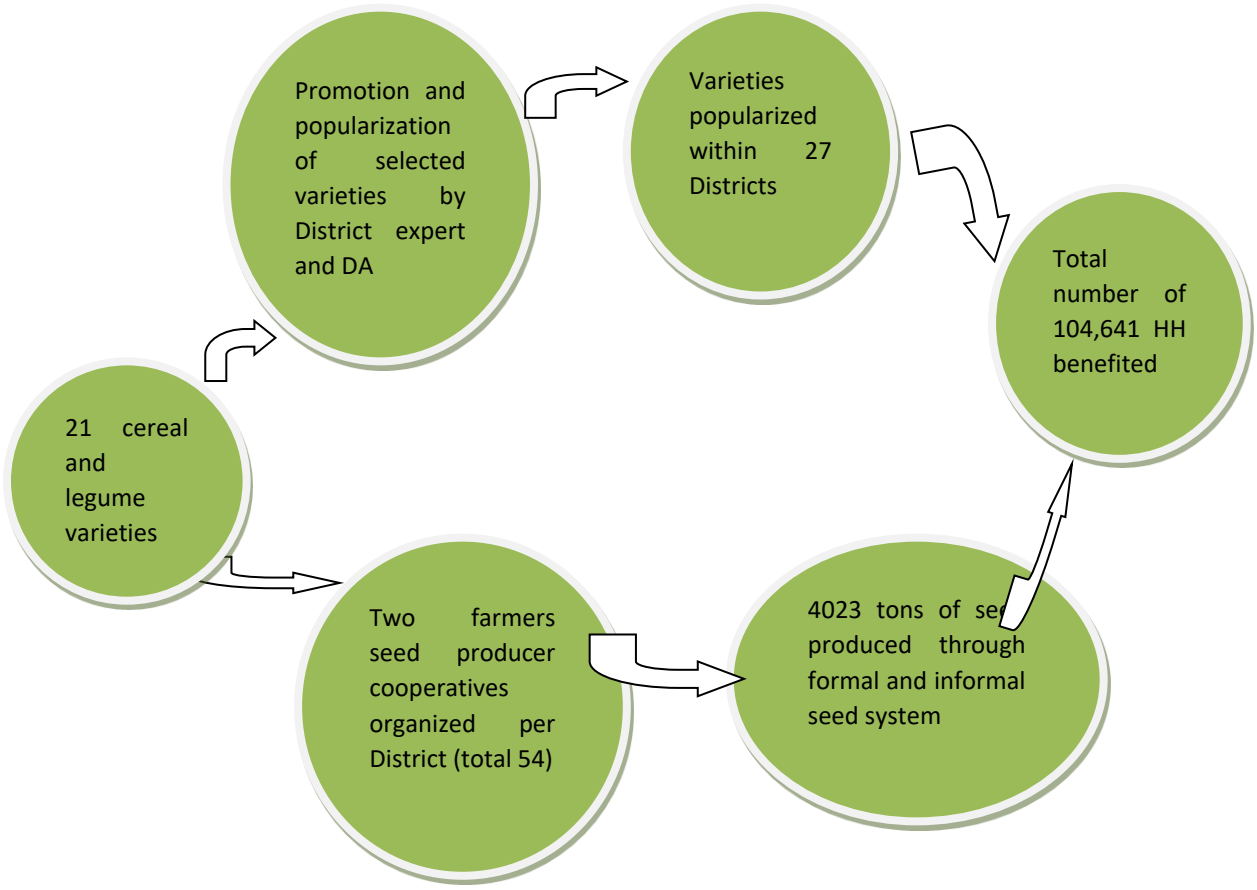
Barley, durum wheat and high land food legumes

All cultivars of barley, durum wheat, faba bean, field pea, kabuli chickpea and lentil are targeted for scaling will be those preferred by farmers (male and female) and the industry. To catalyze the process, external funding and alignment to the country's development strategy is required. The crops and locations to be used in the scaling project are aligned to crops and areas identified by Ethiopian Agricultural Transformation Agency (ATA) for the newly developed agricultural commercialization clusters. Commercial clusters are selected based on potential for production and marketing of a particular commodity. ATA has identified wheat and malt barley in Oromia region and wheat in SNNPR and Tigray for commercialization. Indeed, the required institutional and policy environment do exist to sustain scaling-up efforts beyond the intervention or the AR project's duration. Cereals and food legumes are priority crops in the government five years plan for food and expand align to the second Ethiopian Growth and Transformation Plan (GTP-II: 2015-2020) and the Agricultural Growth Programme (AGP: 2015- 2020), bureaus of agriculture in the districts are supporting local seed production through farmer groups, women groups and youth groups and Government introduced Quality Declared Seed scheme for expansion of availability of quality seed involving farmer seed producers are in place.

Phase II will link to and creating synergies with other ongoing projects, especially USAID funded ICARDA project on "Deployment of malt barley and faba bean varieties and technologies for sustainable food and nutritional security and market opportunities in the highlands of Ethiopia", and USAID funded project "Better livelihoods for small holder farmers through knowledge based technology interventions in the highlands of Ethiopia: Increasing the productivity of chickpea in wheat-based cropping system will also be aligned to this scaling project.

Bureau of Agriculture (Bassona Worana in North Shoa, Endamehoni, South Tigray and Sinana, Bale Zone), breweries (Meta Diego, Dashen and Raya), malt factories (Assela Malt factory and Gondar Malt factory) and food factories (Kalyti Pasta and Macaroni factory), Ethio-Italian Durum wheat value chain project, Global Malt Service & Research Centers (Alamata, Debre Birhan, Sinana RCs), Universities (Meda Wollabu Univ.) and Capacity building for scaling up of evidence-based best practices in agricultural production in Ethiopia (CASCAPE) - are contacted by ICARDA-Sub-Sahara Africa Regional Research Platform. They are willing to work for greater impact, effective partnership and diversified funding during AR II.

Impact Pathway



Targets / Zone of Influence

The scaling intends to include both vertical and horizontal integration in AGP areas, by reaching out farmers, researchers, input suppliers, industries, policy makers and extending to reach 27 districts and 68 kebeles together with partners (Table 4). A total of 104,641HHs will be direct beneficiaries in the four regions (Amhara, Tigray, Oromia and SNNPR). Farmers, policy makers, seed growers, National Agricultural Research Centers, BoA and industry are the key drivers of the scaling.

Table 4: Proposed project areas and beneficiaries of barley, durum wheat, food legumes technologies-Phase II.

Region	Zone	No. of District >2000 masl*	No. Kebeles*	Commodity	Potential beneficiaries (HHs)**	Actual beneficiaries (HHs)	Area (ha)	Seed required (ton)	Women & youth (30%)
SNNP	Hadiya	3	12						
				Barley	78,856	1872	468	47	541

Region	Zone	No. of District >2000 masl*	No. Kebeles*	Commodity	Potential beneficiaries (HHs)**	Actual beneficiaries (HHs)	Area (ha)	Seed required (ton)	Women & youth (30%)
				Durum wheat	163,228	6048	1512	227	1814
				Faba bean	102,252	2616	653	131	785
				Field pea	42,567	1392	348	52	417
				Kabuli Chickpea	NA	1596	398	557	479
					386,903	**13,524**	**3,378**	**1014**	**4056**
Oromia	Bale	5	20						
				Barley	94,215	11,513	5,757	576	3454
				Durum wheat	170,579	5115	2557	384	1534
				Faba bean	43,544	2595	666	133	778
				Field pea	19,972	1200	300	45	360
				Lentil	10,159	615	154	12	184
				Kabuli Chickpea	8,810	540	126	19	162
					347,279	**21,578**	**9,560.95**	**1,591**	**6472**
Amhara	North Shewa	6	24						
				Barley	203,184	11509	2926	293	3453
				Durum wheat	219,192	6205	1552	233	1861
				Faba bean	207,779	9486	2373	475	2846
				Field pea	87,718	2686	673	100	806
				Lentil	103,983	5032	1258	113	1509
				Kabuli Chickpea	76,098	3995	1000	140	1198
					897,954	**38,913**	**9782.1**	**1, 354**	**11,673**
Tigray	South Tigray	3	12						
				Barley	145,306	11604	2901	290	3481
				Durum wheat	367,081	14688	3672	551	4406
				Faba bean	25,580	1024	230	46	357
				Field pea	18,443	288	72	11	86
				Lentil	20,988	900	226	20	270
				Chickpea	37,473	1992	499	70	597
					614,871	30,476	7, 601	1,488.115	9,147

Region	Zone	No. of District >2000 masl*	No. Kebeles*	Commodity	Potential beneficiaries (HHs)**	Actual beneficiaries (HHs)	Area (ha)	Seed required (ton)	Women & youth (30%)
Total		**17**	**68**		**2,667,007**	**104,641**	**77,509**	**7,196**	**31,348**

**Potential beneficiaries could be through technologies; knowledge, skills and services

- Seed production in belg season with supplemental irrigation should be done (testing possibility of barley and durum wheat seed production i.e seasonal intensification and provision of seed for main season production)
- Experiment on management of foot rot in faba bean (in the south generic research should be done, soil amendment and other control options)
- Adaptation trial on acid tolerant crop species (eg Acid tolerant lupine for food feed)
- Action research on different cereal, legume and root crops should be done

Gender

About 30% of female headed households and youth will be involved in scaling the cereals-legume technologies in all target districts. The technologies that will be scaled in the second phase were selected with the involvement of female and youth farmers. Male and female farmers were involved the election of cultivars using agronomic traits and yield criteria (examples: Figures 1 & 2). Therefore, female headed households will benefit from the scaling in terms of household income increase, food and nutrition security of the households in general and women and young children in particular. It should be noted that the crop cultivars selected during Phase-1 are gender neutral and can be adopted by all farmers. The introduction of high yielding food legumes in the scaling will help farmers mainly female famers through reduced nitrogen application to their cereal crops as a result of legume nitrogen fixation. Moreover, disease resistance of cereals and food legumes will save cost of production and reduce farmers mainly female farmers from fungicide sprays that require hard work. Concerning durum wheat and malt barley, factories were involved in selecting high yielding and industry preferred traits.

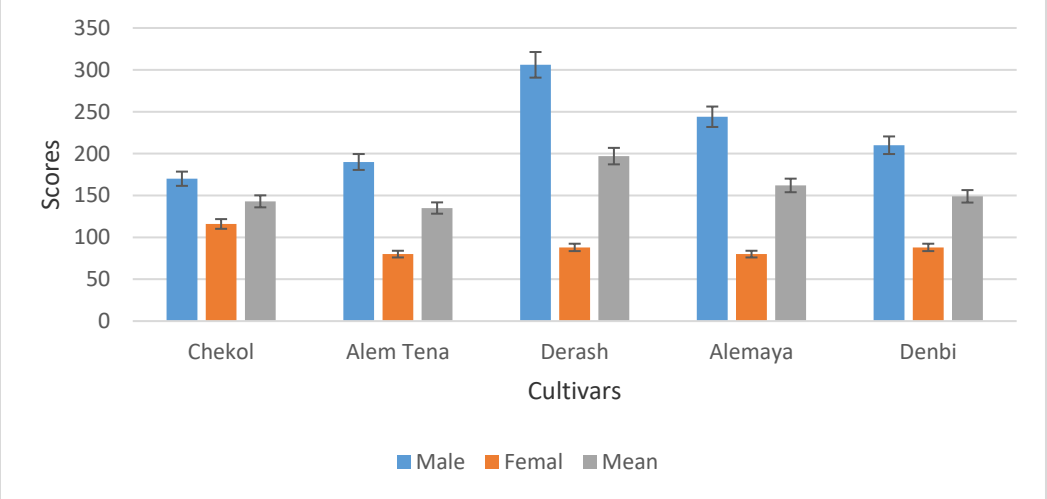


Figure 1. Men and Women farmer selection of lentil PVS based of key agronomic traits-Ilu Sanbitu

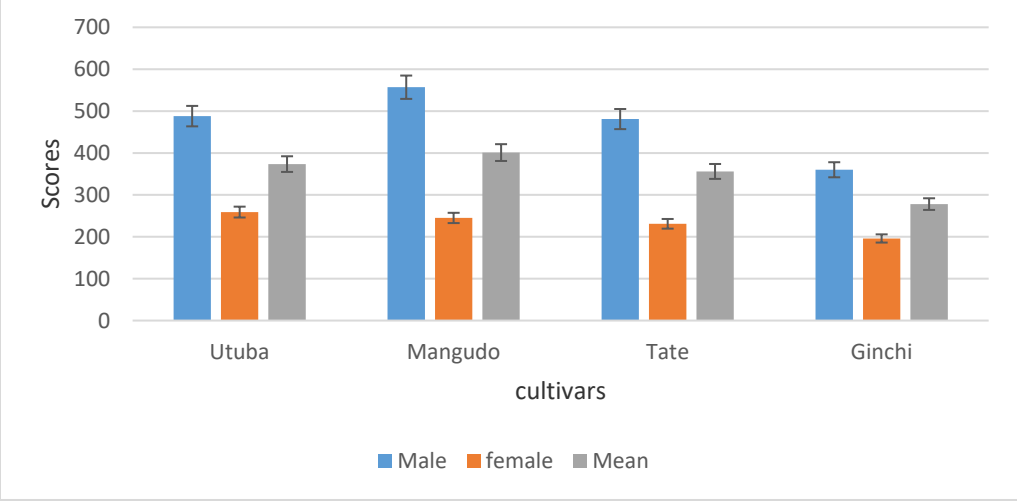


Fig-2. Men and Women farmer selection of durum wheat PVS based of key agronomic traits-Selka

Arrangements Required for Monitoring and Evaluation

Given the involvement of various institutions and professionals, a participatory monitoring and evaluation (M&E) system will be established in collaboration with ICARDA, ILRI-AR, the National agricultural research systems and farmers to obtain improved structured feedback on the implementation of the project. Agreements between the participating institutions will ensure efficient management of the project and those obligations and mutually agreed commitments are respected, delivered and reported. Steering Committee meetings, field visits as well as planning and annual meetings will ensure effective monitoring and evaluation process. Regular IP meetings will be the venues where reports will be reviewed and the course of corrective action developed.

Communications and Knowledge Management / Transfer

Below are alternative methods that will be used to communicate progresses, lessons learned and impacts of scaling efforts.

- Farmers field days
- IP meeting
- Flyers, leaflets, posters, manuals, policy briefs, evidence briefs, case studies, fact sheets, Blogs, website reports, scientific papers, proceedings
- Seminars, workshops,
- Radio, video documentation, experience sharing

Capacity development/ Transfer

Capacity development will have done by AR project, ICARDA and other partners. The capacity development includes training of farmers (male & female), seed growers, extension staff and young researchers (Table 3). To examples are given below.

a) The Italian durum wheat value chain project can support

- Research capacity building (Debre Zeit and Sinana)
- Enhancing value adding activities BOA extension services
- Capacity building of cooperatives (storage and seed cleaning, small scale lab etc))
- Intensive work on creating access to proper markets and
- Model initiatives on seed value chains and grain supply to pasta makers

b) Africa RISING supported trainings

- Training on new technologies and practices
- Vehicle at zonal level for monitoring and evaluation of scaling out/up technologies
- Input supply (early generation seed)
- Demonstrations and participatory new variety evaluation of cereal legume technologies
- Preparation and distribution of brochures and technical manuals.
- Documentation and publication of research findings

Budget break down

SN	Major activities*	April -September 2017			
		Personnel costs (USD)	Operational costs (USD)	Institutional costs (USD)	Total (USD)
1	Participatory variety selections (30%)	20910	7800	-	28710
2	Demonstration/validation of technologies selected in Phase-I (20%)	13940	5200	-	19140
3	Training (farmers, DAs, Seed growers and graduate students: 20%)	13940	5200	-	19140
4	Scaling (Monitoring and evaluation, field days, documentation, linkages and supports to scaling partners: 30%)	20910	7800	-	28710
		69,700	26,000	26,785.45	122,485.45

Scaling niche-specific Input delivery systems in the Ethiopian highlands

Background and Justification

Soil fertility decline is considered as the major root cause for decline in per-capita food production in Ethiopia, aggravated by soil erosion (Shiferaw and Holden, 1999; Nyssen et al., 2004), nutrient mining (Haileslassie et al., 2005), competition for biomass for multiple uses (Berhanu, 2005), and low or no application of mineral fertilizers (Devereux, 2000). As a response, successive Ethiopian governments financed the import of chemical fertilizers, with the volume of the import increase from 200,000 to 894,000 tonnes between the years 1994 and 2014. However, despite these increasingly large investments there is no convincing evidence showing that increased fertilizer application led to proportionally increased crop and livestock yield per unit of inputs.

Limited response of crops to the application of fertilizers (mainly N and P fertilizers) can be partly explained by the critical deficiencies of multiple micro and secondary nutrients, which are holding back the potential of rainfed and irrigated agriculture. When key soil nutrients become a limiting factor water, fertilizer and other farm inputs may be wasted, since a plant will only grow and develop to the extent that its most limiting growth factor will allow (Mengel, 2012).

Recognizing the challenges, the Agricultural Transformation Agency (ATA-Ethiosis) under the umbrella of the MoANR of the Government of Ethiopia has been developing soil fertility maps in the country in close collaboration with the African Soils Information Services (AFSIS). The Government has also established five fertilizer blending plants to promote the intensification of agricultural production in areas of the Ethiopian Highlands with higher growth potential. The individual plants are being managed by Farmer Cooperative Unions (FCUs) in Amhara, Oromia, SNNPR and Tigray and became operational. The plants will permit the production of a wider range of fertilizer specifications that can be tailored to the specific soil conditions that are found in different areas of the country. However, there are research findings, including by AfricaRISING Phase-I projects, indicating that the soil maps created for the different regions (e.g. Tigray) are not yet accurate enough to assure farmers about potential benefits by applying the the suggested various fertilizer blends. In general, these gains have not accrued from the Government of Ethiopia's rapidly increasing imports of chemical (N and P) fertilizers todate, suggesting that the technical backstopping in fintuning recommendation domains proposed here might well be essential to the success of the ongoing initiatives. Field experiments also showed the need for targeting the various forms of blends, addressing the variability within the landscape in terms of soil types, water regimes, landscape positions and responding to farmers' production objectives.

Despite the ongoing multiple efforts, the challenge the country has been facing in appropriate use of fertilizer inputs are: 1) there is no convincing evidence suggesting that the types of fertilizers currently imported in large amounts are reflecting the real needs of the various soil types, cropping systems and landscape positions of the country; and 2) The fertilizer plants may not be able to produce the required type and amount of fertilizer blends for the specific landscapes unless additional information is generated on the agronomic and economic efficiency of the various fertilizer blends for specific locations and

production systems. Taking the more integrated and targeted approach to fertilizer use that the work proposed here aims to support (i.e. as part of a broader set of interventions aimed at enhancing system productivity) could improve the agronomic and economic benefits. This project is now seeking to encapsulate its findings into sets of fertilizer recommendations for various soil types, crops and farming systems and other specific situations and institutionalize the research and scaling-up approaches.

Moving to scale while appreciating diversity

An interesting phenomenon relating to the strategy of most research and development actors to work at scale is how the agricultural landscape is perceived in the majority of the cases. It is equated to several plots or many fields rather than viewing the landscape as a mosaic, often highly fragmented, of farmers' fields of differing fertility status, pasture lands, woodlands and forests and other infrastructures. The inherent challenges in social, economic and policy dimensions, the ability of development actors to make concerted and significant landscape level impacts through application of inputs (e.g. chemical fertilizers) is seriously impeded by the lack of information about niche specific landscape constraints and conditions at appropriate intervention scales. This has resulted in the past in blanket fertilizer recommendations, abandoning of soil and water conservation structures by communities, challenges in scaling-up land and water management interventions, in duplication of research efforts, and in wasteful dissemination expenditures trying to avail all known options to communities, without considering the feasibility of the respected interventions. This project will generate tools and methods to understand landscape dynamics for targeted input supplies that would be increasing crop productivity, fertilizer use efficiency and economic returns to investments.

Africa RISING and ICRISAT's successful approach in the wheat systems of Ethiopia on landscape -based nutrient management serves as an entry point. The approach is the adoption of soil-test based nutrient management recommendations of key nutrients along with quality seeds of high-yielding cultivars in differing landscape positions and socio-economic categories, particularly women. We will follow a "service" rather than "supply" orientation, and inputs would be used as an entry point to facilitate landscape change.

Research and Scaling-up strategy

The principal strategies that will guide our research are: i) Engaging in an inclusive partnership with diverse stakeholders (fertilizer input providers, extension systems, local policy makers, farmers' union) leading to local action, innovation and sustainability; ii) based on local evidence, employing various scaling up tools (e.g. GIS tools, co-designing a scaling-up plan with NGOs, local and regional government extension channels) to reach wider communities; iii) Creating local capacity for testing and validation of fertilizer and other soil fertility management options (e.g. using mobile laboratories); iv) Using macro and micronutrient fertilizers as entry points to facilitate adoption and dissemination of integrated soil fertility management at landscape scales; v) Using Innovation platforms, including those established and facilitated by AfricaRISING for institutionalizing our tools and methods for local action and wider influence; and vi) Cross-country learning between Africa RISING sites in SSA as a starting initiative. Using GIS and

Remote sensing tools, we will identify hotspots in the landscape (irrigated and rainfed) at districts scale, where our interventions would bring about a significant benefit at farm and landscape scales.

An example of scaling up strategy based on the evidence we have generated in Tsbet kebele, Endamehoni district in Southern Tigray region is described as follows. The evidence generated by Africa RISING phase-I research indicated that slope and soil depth could be powerful proxy indicators of soil fertility status due to its strong correlation with soil erosivity, soil carbon, soil water holding capacity CEC and nutrient levels. Accordingly, crop response to application of chemical fertilizers was significantly high only in landscapes with slopes <30% (marked green and yellow), while the majority of the landscapes beyond 30% of the slope (marked red) did not have any agronomic or economic benefits at landscape and district scales. The implication was that, as presented in Fig 1 only about 25% of the landscape could be targeted by chemical fertilizers while the remaining landscape should be treated with organic fertilizers like manure, green manuring and soil and water conservation interventions.

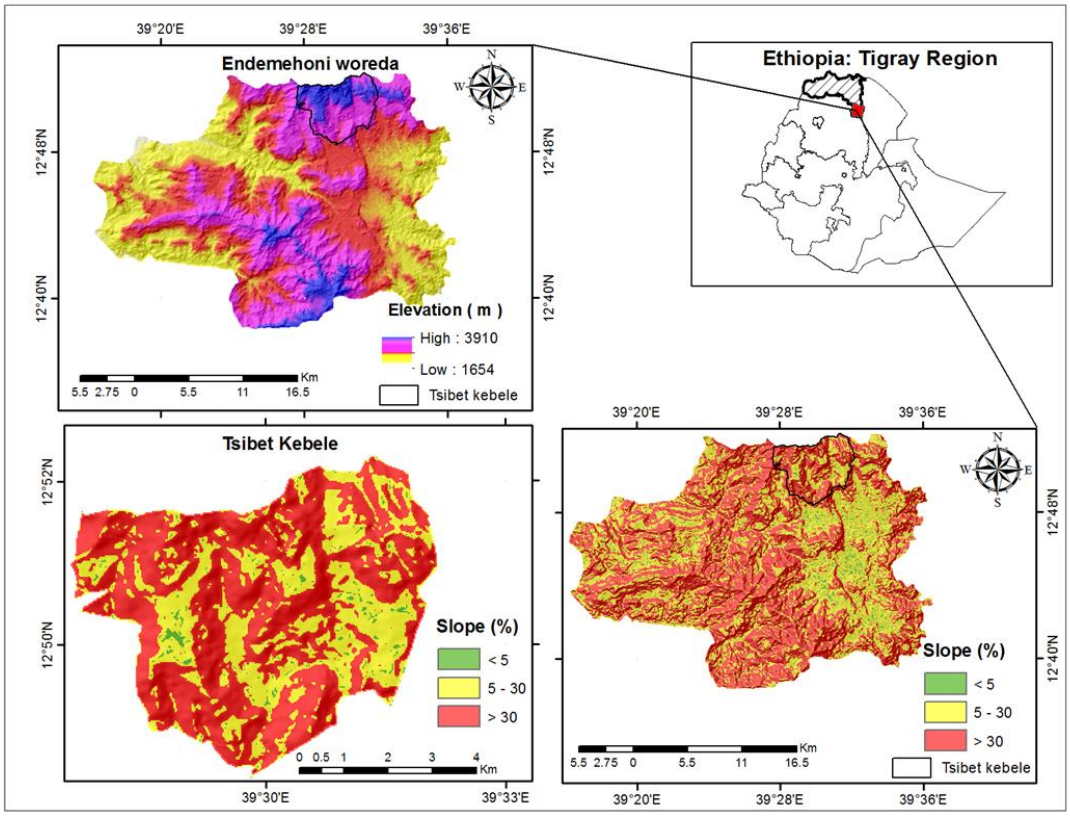


Fig. 1. Scaling-up of inputs using top sequence as a proxy indicator and its implication on crop response to chemical fertilizers in Endamohoni woreda.

Describe the nature of innovations to be scaled (technologies, approaches).

We have three different types of technologies and practices to Piloting of best bet options.

1. We will Pilot differing fertilizer blends that would suit various soil types, landscape positions and cropping systems at district and zonal levels for validation;
2. We are seeking for a country-wide influence by institutionalizing our decision guides and targeting tools for fertilizer recommendation at regional and national scales;
3. We will provide soil health certificates for those where we have solid data and participatory engagement in the last few years;

We will develop minipacks and micro-doses of identified fertilizer blends as per the suggested number of potential target crops following landscape approaches.

- We will provide soil health certificate for about 3700 farms in total in the respective regions, particularly to those who have been working with us on fertilizer recommendations to date.
- 5000 minipack sets of blended fertilizers as per the findings of Africa RISING Phase-I targeting women and men farmers farming in midslopes and selected valley bottoms;
- 2000 Minipack sets with Potassium fertilizers mainly in localities dominated by Nitosols and in-home gardens, where horticultural crops are the major commodities;
- 2000 Minipack sets with Sulphur-based fertilizers only in areas where land degradation is apparent, pH is relatively high and organic matter content of soils is low.
- 500 Minipack sets with Zinc-based fertilizers for areas where the soils are predominantly calcareous carbonate soils, and higher NPK application is commonly practiced.
- 300 organic fertilizer packages (composting, green manuring, minimum tillage and manure management) targeting men and women farmers residing in hillsides and degraded landscapes, where chemical fertilizer were found to be ineffective. .

Research for development procedures

1. In Africa RISING Phase-I, while we have managed to identify what type of soil nutrient is missing where in the Wheat systems and validate crop-response through hundreds of on-farm experiments. We were not able to establish fertilizer rates for each landscape positions and agro-ecologies due to short project time spans. In fact, during the growing season of 2016, and despite lack of funds from Africa RISING, ICRISAT used other sources of funding to continue conducting on-farm trials in Endamehoni and Lemo to establish fertilizer rates for the missing nutrients. This research should be repeated in 2017 in these sites but also in the other regions where on-farm research for establishing nutrient rates was not yet conducted.
2. In parallel with Step -1, we will identify potential kebeles and districts in each region, using our GIS and Remote sensing tools (e.g. Fig 1), where our interventions would work. We will train the extension staff and woreda officers on the targeting tools and approaches but also help them to estimate the type and amount of inputs required to reach the identified and targeted communities, particularly women led households.
3. We will use Mobile labs to validate our interventions in selected villages. This will be done by asking representative farmers (including women farmers) to bring soil samples from their own farms and various landscape positions (partly guided by our team using our GIS tools), testing the

soils together with the farmers and suggest negotiated farm decisions. We will also cross-check their assessments with yield estimations across the landscape gradients.

4. Parallel to the above interventions, we will create strong capacity in using the various tools and inputs at district level and facilitate learning between communities, teams and regional research and development systems to adopt the interventions, tools and approaches at various scales.
5. As most of these fertilizer and other soil fertility management inputs are already within the respective districts and regions, mostly facilitated by the Bureau of Agriculture, we will help in identifying appropriate kebeles and location for scaling-up of these innovations by closely working with the local institutions, NGOs (e.g. GIZ) and other development partners.

Institutionalization and Scaling-out of soil fertility management interventions

There is an on-going national effort to develop soil-test based fertilizer recommendations in the country. The soil fertility map ATA and its partners have been doing, which was a very important Investment, was based on soil nutrient analysis but rarely considered crop responses to input application, or farmers' production objectives. Moreover, the available information is widely dispersed and rarely add-up due to differences in protocols, treatments, approaches, scales, locations and production systems. This has created problem in data aggregation and policy recommendation for a while. This initiative, capitalizing on the already established soil fertility national platform, and based on the evidence it has generated during phase-I of the Africa RISING project, will facilitate changes in approaches and implementation strategies. We have developed a cropping system and landscape-based targeting tool that has been attracting attention of the national system. This project would also scale-out local level guides that would promote agronomically efficient and profitable input delivery systems by creating local capacity through training and promotion of simple decision tools that could guide investment. Decision tools that would recognize landscape specific targeted fertilizer recommendations would benefit farmers but also reduce fertilizer costs for the farmers and the importing agencies. This tool could be also used for targeting various forms of climate-smart technologies and practices, including interventions for landscape water management, and identification of bright spots for development of women market gardens.

Progresses made to date in institutionalizing and scaling of these tools and methods:

On November 3rd, 2015, following a recommendation made by an EIAR senior staff, EIAR DG has asked ICRISAT to present the experiences of AfricaRISING project on niche specific soil fertility management to the soil scientists of EIAR at the headquarters. Almost all the Directors and senior staff participated in the seminar, chaired by the Director General, Dr Fentahun Mengistu;

On Dec 18th, 2015, a follow-up workshop was conducted based on the recommendation of the DG of EIAR and other senior directors a nation workshop entitled 'Decision support tools for appropriate fertilizer recommendation in Ethiopia'. It was organized by Africa RISING-ICRISAT, EIAR, CIAT and GIZ team by inviting all the major stakeholders in fertilizer and soil fertility research in the country, including

representative of regional research institutes, ATA, GIZ, multiple Universities, MoANR and other stakeholders;

On December 1st and 2nd, 2016 ICRISAT and CIAT have organized the second national workshop in collaboration with EIAR and GIZ to evaluate progresses made in developing decision guides for fertilizer application and develop a database by bringing the available soil-related data together and analyze trends and benefits;

On December 5th ICRISAT, EIAR and ATA have agreed to re-analyse the data generated by EIAR and ATAT in 65 districts of the country following Africa RISING methodologies and approaches. It is a work in progress.

On January 23rd, our team held a meeting with the Minister of Agriculture and Rural Development, His Excellence Dr. Eyasu Abrha to discuss about institutionalizing best approaches and practice on soil fertility management.

Additional innovations to be scaled

- Develop Soil health indicators, which will be tested and promoted in selected districts and the information shared with different stakeholders. We will also enhance the awareness amongst the policy makers, development workers, researchers and farmers, which could be used to assess environmental services
- Training material for efficient management of fertilizer blending plants, addressing local needs developed and institutionalised. ToTs could also use it.
- Soil health status maps for the selected region to share the information with different stakeholders and enhance the awareness amongst the policy makers, development workers, researchers and farmers for increasing agricultural productivity
- Generic Research protocol that could be used by research and development partners for targeting systems;
- Capacity building events in targeting niches and improved management of agricultural inputs, particularly fertilizers for woreda-level experts.

Benefits

Major Outputs of the Niches Africa RISING project are as follows:

1. Revised farming system-based soil fertility management maps created for the target zones and widely shared
2. About 3700 farmers would be awarded Soil Health certificates, along with recommendations per farm units.
3. About 13,500 households would be benefited through increased use of fertilizer inputs in targeted landscape positions
4. Increased yield of grain and crop residue in targeted landscapes / woredas, in the target zones

5. Decision tools and policy guides for disseminating targeted use of inputs for intensification in the target zones
6. Disseminating technology and institutional recommendations through various communication channels

Research Questions

a) What are the landscape scale agronomic benefits of systematic application of micro and macro nutrients 'in deficit' on food security, nutrition, water productivity, crop productivity, irrigation efficiency and disease incidence?
b) How does farmers' decision criteria change from woreda to woreda in allocating external inputs / fertilizers at farm and landscape scales? Does it coincide with scientific soil quality indicators? What are the drivers of these changes?
c) How can we facilitate quality input delivery system in the various regions, with differing capacity and cropping systems?
d) How do we operationalize a country-scale fertilizer recommendation at scale given the landscape diversity, agroecology, differing socio-economic status and market incentives? What are the drivers of success?
e) How can research influence fertilizer blending plants that would reflect crop response of specific regions in the various cropping systems?
f) How can we reach wider communities with best-bet dissemination approaches; e.g. minipacks, microdosing?
g) Which scaling mechanism and approach is successful in reaching out more communities and systems in short period of time, project life?
h) What type of institutional arrangements are required to scale-up best practices to policy makers and key players (particularly NGOs)? Institutional alliance, innovation platforms and other forums
i) What type of extension and dissemination materials required to promote efficient use of inputs/ fertilizers? Tailored extension guides and methods for identification of hotspots? nutrient deficiency symptoms? policy briefs, maps and decision tools?

Development Partnerships

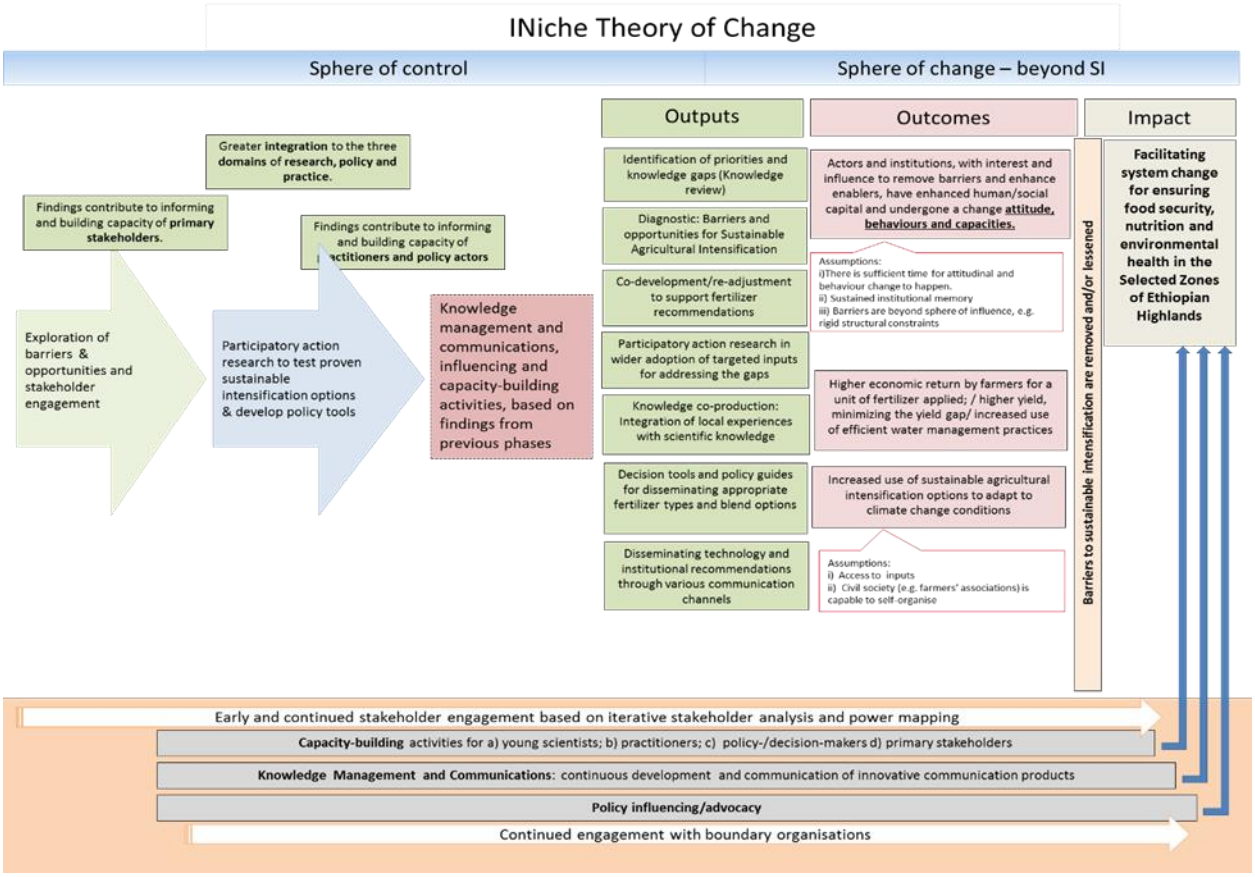
Table 1. Piloting regions and potential partners for piloting soil fertility management options

Region	Development partners and their competence
Tigray Region	Endamehoni District Bureau of Agriculture, which is keen to scaling out and facilitating adoption of targeted input use to the wider communities in the different kebeles Ethiopian Institute of Agricultural Research, through Mohoni Research Centre, which was a major partner in testing the various fertilizer combinations and targeting in South Tigray Zone
Southern Tigray Zone	GiZ-Germany, which is very keen to support integrated soil fertility management in Ethiopia through its GIZ SLM+ project and working closely with ICRISAT on the same; Agricultural Transformation Agency (ATA), which is already working with us in developing common fertilizer protocols at a country scale.

Region	Development partners and their competence
	Institute for sustainable development (ISD), which has an interest to scale-up best-bet fertilizer recommendations and practices through its local partners
SNNRP region Hadya Zone	Lemo Bureau of Agriculture, Hadya Zone, which is keen to scaling out and facilitating adoption of targeted input use to the wider communities in the different kebeles. This district administration has been working with us on testing fertilizer blends, which would be key for scaling out and facilitating adoption; Interaid France, an NGO with strong presence in the region and willing to disseminate best-bet soil fertility management options to scale and expressed strong interest to collaborate with AfricaRISING/ ICRISAT on the same. Southern Regional Agricultural Research Institute (SARI), through Areka Research Centre, which was a major partner in testing the various fertilizer combinations and targeting through its research centres in Hadya and Areka GiZ-Germany, which is very keen to support integrated soil fertility management in Ethiopia through its GIZ SLM+ project and working closely with ICRISAT on the same SOS Sahal, which has confirmed its interest to scale-up best-bet fertilizer recommendations and practices through its local partners and smaller NGOs
Amhara Region South and North Wollo Zones	Worreilu District Bureau of Agriculture, South Wollo Zone, which is keen to scaling out and facilitating adoption of targeted input use to the wider communities in the different kebeles. This district administration has been working with us on agricultural intensification of degraded landscapes, which would be key for scaling out and facilitating adoption; Wollo University, which has been a major partner of ICRISAT in integrated landscape management and soil fertility management. Amhara Regional Agricultural Research Institute (ARAR), through Sirinka Research Centre, which was a major partner in testing the various fertilizer combinations and targeting; GiZ-Germany, which is very keen to support integrated soil fertility management in Ethiopia through its GIZ-SLM+ project and working closely with ICRISAT on the same; Save the Children Ethiopia, which has confirmed its interest to scale-up best-bet fertilizer recommendations and practices through its local partners and wider NGOs network

Impact Pathway

The hierarchy of an impact pathway begins with the project outputs, followed by a chain of intermediate outcomes that are then followed by the wider and often longer-term outcomes (Douthwaite et al. 2003). The impact pathway of the Africa RISING project will help us to target beneficiaries, identify their challenges, develop and monitor products and understand process (change in attitudes, skills and knowledge), boundary partners (i.e. individuals and organizations influenced) and their contributions over time and scale. It will inform the project team about what needs to happen for the AR project output to be transformed, over time, into impact on highly aggregated development indicators. It is the bridge between project outcomes and eventual impact.



Targets / Zone of Influence

- From the current crop area at the national level, around 45% is treated with chemical fertilizers[1]. Assuming that we are targeting 15 kebeles in 6 districts and 5 zones of the four regions, and assuming that there are about 2000 household of potential adopters per kebele, our target farmers for our piloting would be 30000 households. Considering that only 45% are going to adopt our interventions as indicated above, we will reach 13500 households with our piloting of soil fertility management options in Amhara, SNNPR and Tigray regions.
- We will predominantly target wheat-based and small cereal related cropping systems

Table 2. Potential target kebeles for piloting AR Soil fertility management options.

Region	Zone	Woreda	Number of Kebele (Selected based on road access)	Potential beneficiaries (2000 hh per kebele)	Actual beneficiaries, who already

[1] Zerfu and Larson, 2011 Incomplete Markets and Fertilizer Use: Evidence from Ethiopia. World Bank

					use fertilizer (45%)2
Amhara	South Wollo	Worreilu	3	6000	2700
	North Wollo Zone	Tehuledere	3	6000	2700
Tigray	South Tigray	Endamohoni	2	4000	1800
		Offa	2	4000	1800
SNNPR	Wollaita	Areka	2	4000	1800
	Hadiya	Lemo	3	6000	2700
Total				30,000	13,500

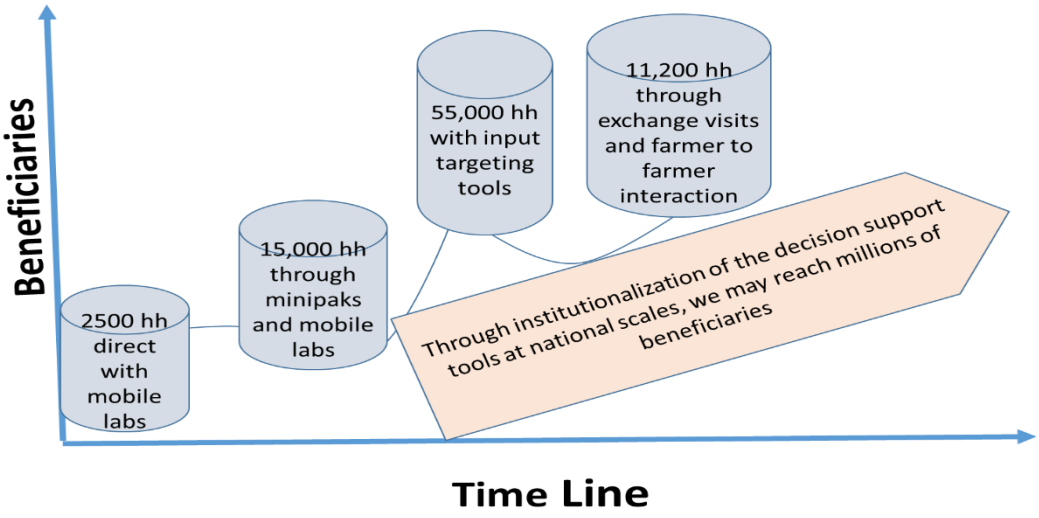


Fig 2. Schematic presentation of Scaling-up strategies of inputs

Arrangements Required for Monitoring and Evaluation

Socio-economic and biodiversity benchmarking / baseline will be conducted at household and community scales to permit the quantification of project impact on farmer welfare in terms of income changes and changes in household nutrition and other biodiversity indicators. Knowledge derived from the assessment will constitute an important outcome of this project and will be used as feedback loop to respond to institutional and technological gaps.

The initiative is on-going and has attracted attention from various national and regional institutions. We will develop and use M&E tools to monitor benefits from these interventions overtime, compared to non-

[2] IBID

intervention scenario. We will use various M&E tools to demonstrate impact and cost-effectiveness in order to promote continued and extended adoption of input use, including through:

- Baseline studies on current household production, transaction costs and household income.
- Longitudinal cohort studies to monitor change with time
- Outcome mapping to develop strategies to influence policy makers and investors (e.g. EIAR, ATA, MoANR) and show changes in knowledge, attitude and practice as a result of the project
- Participatory learning and action studies to monitor livelihood changes and empower participants through self-reflection.
- Develop feedback mechanisms to check appropriateness of the tools and methods.

Inclusion of Women and Youth

Women farmers are commonly financially constrained to access expensive inputs, including fertilizers. On the other hand, women are commonly grow vegetables, fruits and other marketable produces around their houses, in the form of gardens, including in wheat-dominant farming systems. This project would address gender specific production constraints through gender targeted cost-saving choice of soil fertility management options, with targeting fertilizers around home garden crops, but also capacitating women development agents who would understand the issues and address them in participatory arrangements. We will also develop the baseline information and the assembly of input use and management experiences from the perspective of women and youth and develop interventions along with gender specific recommendation domains. We will identify challenges specific to women and youth across the input value chain. We will also organize women and youth targeted forums for joint learning and action. The tools and methods emerging from this project will have also a gender disaggregated information.

Communications and Knowledge Management / Transfer

The project will develop communications strategies tailored for specific actors as identified in the Africa RISING Communication strategy and designed through participatory processes begun in the inception workshop and continued through the life of the project. There will be Africa RISING level and individual project level communication and uptake strategies. The project will develop accessible information storage and sharing mechanism for materials, outputs, and products in different formats. Communications strategy will include identification of key target groups and key communication opportunities for sharing results of existing and new projects with others; and will facilitate and support projects to make use of these. It will establish and /or facilitate Fertilizer Advisory Group, policy champions and professional societies for improved communication and advocacy. We will use website, web-blog, newsletters, posters, flyers, video-clips, publications, reports, radio and other communication tools for internal and external communication and knowledge sharing.

Budget Details

S.No	Explanation (type of costs)	Total
1	A. Personnel	
	Principal Scientist	34,869.00
	Postdoc	9,400.00
	Research Officers	5,400.00
	Community facilitators	1,200.00
	Extension facilitators	1,200.00
2	B. Operations	
	Field costs	18,000.00
	Equipment	6,900.00
	Training / Workshops	19,000.00
	Publications	600.00
3	C. Travel	11,400.00
Total direct costs		107,969.00
Indirect costs (18.7%)		20,190.00
TOTAL		128,159.00

Scaling out small-scale mechanization in the Ethiopian Highlands

Background and Justification

Good agronomic practices required to close yield gaps in the Ethiopian Highlands are well-known (e.g., precise plant population, precise seed and fertilizer placement), but the fact that the application of these technologies generally increases the demand for farm power (be it human labor, draught animal power or engine power) is seldom recognized. The problem is compounded by the fact that farm power available per hectare has been growing very slowly in Ethiopia.

Responding to this need, the Ministry of Agriculture and the Ethiopian Agricultural Transformation Agency developed a draft national mechanization strategy in 2014. The aim of the strategy is to increase the farm power available to Ethiopian farmers 10 folds (from the current 0.1 Kw ha-1 to 1 kW ha-1) by 2025, with at least half of this power derived from fuel and electric engines. Large tractors (with four wheels and two axles) are well suited to large-scale and medium-scale Ethiopian farmers. But these farmers only represent about 10% of the estimated 14.7 million farmers in the country. Another form of mechanization, appropriate to the scale of the vast majority of Ethiopian farms is required.

Starting from 2009, the Ethiopian Government started to import lower powered (8 to 15 HP), more affordable (about US$2182) and easier to maintain single axle two-wheel tractors (2WT) mainly from China. The import of up to 4,100 2WTs between 2009 and 2014 has been reported. These 2WTs, however, are imported with land preparation implements (rotary hoes and mouldboard ploughs) which are used in China in wet paddy fields. 2WTs are simply not powerful enough to pull these implements (or any conventional tillage implement for that matter) in dry rainfed conditions for most soils. To solve the problem of crop establishment using such low-powered machines, CIMMYT (the International Maize and Wheat Improvement Centre) and its partners have been testing and promoting the use of various seeders allowing single pass direct seeding in unploughed fields in different parts of Ethiopia. Single pass direct seeding drastically saves time and labor compared with conventional crop establishment. Results from the FACASI project (Farm mechanization and Conservation Agriculture for Sustainable Intensification (http://facasi.act-africa.org/) indicate that single pass direct seeding may cut the time needed to establish a crop by a factor 8 compared with conventional methods, using negligible amount of fuel (about 5 liter per ha). Moreover, results from the Africa RISING (Africa Research in Sustainable Intensification for the Next Generation) project in the Ethiopian Highlands (http://africa-rising.net/where-we-work/ethiopian-highlands/RISING) indicate that single pass direct seeding increases wheat yield in the Ethiopian Highland by 1.6 t ha-1 on average compared with conventional crop establishment. This is due to better tillering with a crop planted in rows compared to broadcast, as well as greater precision on the planting depth and greater precision in fertilizer application (banded right underneath the seed, where is it most useful).

Describe the nature of innovations to be scaled (technologies, approaches)

During Africa-RISING phase 1, the CIMMYT protocol tested the use of 2-wheel tractor based planting, transport and water pumping for irrigation services in the Ethiopian highlands. In the proposed second

phase technologies to be scaled are 2 WT based ploughing and planting, shelling and threshing, harvesting – walking harvesters, potato planting, trailers for transportation, and water pumping using 2 WTs for drip-irrigation of high value crops such as vegetables. The 2 WT based equipment available through CIMMYT and its partners include 8-20 HP 2 WTs, planters, disc ploughs, shellers, threshers, harvesters and trailers, and farmers will have access to these during the lifespan of the project.

Smallholder farmers will have access to these tractors and equipment through services provided by individual and youth group service providers (SPs). In each project site service providers, individual and youth groups, will be identified with the help of the Africa-RISING site coordinators and Development Agents (DAs) and trained by the project team. For the youth group service provider model, each group will have 10-12 members who will all receive technical and agribusiness training during the project.

The following approaches will be used in collaboration with the Ministry of Agriculture through regional bureaus of agriculture and co-operatives in the different regions in order to reach more smallholder farmers and other stakeholders:

1. Off-season/dry season demonstrations of 2 WTs, planters, shellers, threshers, walking harvesters, trailers and water bowsers as part of awareness and demand creation campaigns in different communities where service providers will be based. These awareness campaigns will be conducted by project staff and SPs in conjunction with partners including regional bureaus of agriculture, co-operatives, farmer unions and equipment manufacturing companies.
2. In-season/cropping season demonstrations of land preparation and planting using 2 WTs and planters at the onset of the cropping season. On-farm demonstrations showcasing wheat, teff and maize planted using 2 WT based planters will be set up in conjunction with Ministry of Agriculture and regional bureaus of agriculture. At the end of the cropping season harvesting using walking harvesters, threshing and shelling will be demonstrated in project communities. Field days will be conducted at the demonstration plots to create awareness and show farmers crops planted using 2 WT based technologies compared with traditionally planted systems. During the cropping season, project staff will also facilitate farmer-to-farmer exchange visits around the project communities in the different regions.
3. Service provision by selected and trained service providers (individuals or youth groups) – under the Africa-RISING project, Ministry of Agriculture and CIMMYT will identify SPs, and it is envisaged that these SPs will operate different lines of business that include land preparation and planting services, harvesting, threshing and shelling, water pumping and transport services in project target communities and beyond. The SPs will provide services not only to individual farmers but also to co-operatives, unions and other different customers depending on their lines of business.
4. Information materials (flyers/bulletins) on 2 WT based technologies and available services will be developed, translated into local languages and distributed to farmers through the network of project partners and SPs.
5. Regional Enterprise/Innovation exhibitions – 2 WTs, planters, threshers, shellers, harvesters and other accessories will be showcased at regional shows where smallholder farmers and other stakeholders involved in agricultural development will be participating. The project and bureau of agriculture staff, SPs and partners will actively participate in these regional events.
6. Round table meetings (at woreda and higher levels) in the different regions will be facilitated by CIMMYT and partners as an avenue to lure more SPs for different business opportunities and linking them to microfinance and market opportunities.

7. Policy change towards promoting mechanization in smallholder agriculture throughout Ethiopia will be facilitated by CIMMYT in collaboration with MoANR of Ethiopia

Benefits

The first phase of the Africa-RISING project created a platform to test various innovations under smallholder farmer conditions. The benefits of small mechanization on planting (opening planting furrows, fertilizer application, seed placement and covering in one pass), threshing, spraying, irrigation and transport have been documented. Although single pass direct seeding using a two-wheel tractor appears profitable and ready for scaling out, and although two-wheel tractors and seeders are relatively cheap (a two-wheel tractor costs about 48,000 ETB (US$2182) and a seeder about 18500 ETB (US$844), it is evident that most Ethiopian farmers will not be able to purchase them individually. Still, they could access mechanization services, delivered by dedicated well-trained service providers. This model – which has been adopted in Bangladesh where a single two-wheel tractor can service up to 30 farmers for planting services – is the model successfully tested by CIMMYT and its partner in various parts of Ethiopia. For service provision to be viable as a business activity, mechanization use rates should be maximized. This means that a model of service provision depending on seeding only (few weeks of demand per year) is unlikely to be viable: other operations – allowed by the versatility of 2WT – should be considered, including operations that are less seasonal or time-bound such as threshing, water pumping and transporting. This guarantees that 2WTs are in productive use for a greater part of the year (benefit to the service providers) and reduce the unit cost of custom work (benefit to farmers receiving the service). The demand for threshing, water pumping and transporting is generally high, even at low labour wages.

Research Questions

The proposed project will follow a research-in-development (R-in-D) approach and quick feedbacks from small mechanization users, both service providers and farmers, will help in the formulation of new research questions. The initial proposed research questions include;

1. What is the effectiveness of service provider business model in scaling out agricultural mechanization innovations/technologies?
2. Which are the best/appropriate business models for inputs, services and output supply in scaling out?
3. What is the effect of mechanizing different farm operations on drudgery, labour productivity and crop yields?
4. What is the effect of small mechanization on employment of the youth, women and men in rural areas of the Ethiopian highlands?
5. What role can the private sector and co-operative partners play in small mechanization technology dissemination and adoption?
6. What is the importance of linkages to value chain finance for adoption and scaling?
7. What are the important entrepreneurship skills required in enhancing adoption, adaptation and scaling of agricultural mechanization technologies?

8. Are roles of the youth, women and men shifted with the introduction of small mechanization in rural communities of the Ethiopian highlands?

Development Partnerships

A strong network of partners has been developed during the first phase of Africa RISING and strengthened through partnership with other interventions including the ACIAR-funded project 'Farm Power and Conservation agriculture for Sustainable Intensification' and the GIZ-funded project 'Appropriate Mechanization for Sustainable Intensification of Smallholder Farming in Ethiopia'. This network includes research organizations, public and private agriculture development organizations, farmer organizations and co-operatives, and already contributes to the scaling-out and dissemination of appropriate mechanization. In the proposed second phase, the CIMMYT team will work together with the Department of Mechanization in the Ministry of Agriculture and Natural Resources (MoANR), Amio Engineering Ltd., International Potato Centre (CIP), International Water Management Institute (IWMI), other manufacturers and importers of agricultural equipment, co-operatives and private sector players involved in tractor hire services. Dissemination of input-output market information and linking farmers to markets will be achieved through close collaboration of project team with co-operatives, traders and processors. International research organizations namely CIMMYT and IWMI will train partners, provide technical backstopping and conduct research in scaling during the implementation of the second phase project activities. In the sister mechanization projects, FACASI 2 and GIZ, CIMMYT and EIAR will be involved in second generation technological improvement, both engineering and agronomy, to improve the performance of service provision based on the demand from service providers through the GIZ and FACASI 2 projects. The improvements on the 2 WT based attachments from these two projects will also benefit the communities where small mechanization is being promoted, including the Africa-RISING 2 project sites. In-kind contribution from the GIZ and FACASI projects will also include adoption studies on small-scale mechanization in sites that have been used for these projects over the past years, including sites used in Africa-RISING Phase 1. CIMMYT recently recruited Dr. Rabe Yahaya who is an agriculture mechanization specialist and he will contribute in-kind towards Africa-RISING 2 through his technical and marketing expertise. The contributions of some of the key partners in the proposed second phase of Africa-RISING are summarized below and it is envisaged that more partnership will develop during the implementation of the project. Partnership with iDE-Ethiopia will develop in the near future. iDE-Ethiopia has expertise in linking smallholder farmers and entrepreneurs to micro-finance institutions in Ethiopia. In Africa-RISING phase 2, linking SPs to sources of finance will be critical for service provision business. Letters of commitment to the Africa-RISING phase 2 project by two key partners, MoANR and Amio Engineering, are included at the end of this concept note.

14. Department of Mechanization, Ministry of Agriculture and Natural Resources (MoANR)
    - MoANR distributes 2 WTs, planters, conventional ploughs, walking harvesters, shellers and threshers in some of the project sites in the wheat, teff and maize growing areas of the Ethiopian highlands.
    - MoANR provide technical experts during training of equipment operators and service providers.

- Through the regional bureaus of agriculture, MoANR links SPs to spare parts shops in the different project regions.
- Through the regional bureaus of agriculture, MoANR backstops the SPs and youth groups in the different regions in collaboration with CIMMYT.
- MoANR will assist in changing government policy on mechanization of smallholder agriculture in Ethiopia

15. Amio Engineering
    - Providing spare parts for the different equipment including tractors, planters, shellers, harvesters and threshers
    - Linking SPs to spare parts shops spread across the different project regions.
16. International Water Management Institute (IWMI)
    - Facilitating irrigation of high value crops in communities established in Africa-RISING phase 1
17. International Potato Centre (CIP)
    - Providing potato planters purchased in Africa-RISING phase 1

Impact Pathway

The effect of the proposed project activities at outcome and impact levels are summarized in the table below;

Outcomes	**Verifiable indicators**
Suitable machines/equipment available in Ethiopia	Number of two-wheel tractors and planters imported annually into the country
	Number of trailers, harvesters, threshers and shellers manufactured annually in the country
Accelerated delivery and adoption of two-wheel tractor-based technologies	Number of service providers in the project sites
	Average income of service providers in the project sites
	Number of smallholders adopting two-wheel tractor-based technologies (land preparation, seeding, transporting, shelling, threshing, water pumping)
Two-wheel tractor-based market systems supported by private (and pubic) companies	Number of private (and public) companies investing in two wheel tractor-based mechanization
	Number of financial products adapted to two-wheel tractor-based mechanization
	Number of accessible 2WT spare part dealers

Impact	**Verifiable indicators**
	Average yield of the main crops

Impact	Verifiable indicators
Increased agricultural productivity, food security and access to nutritious food	Yield difference between women headed households and men headed households for the main crops
	Average food self-sufficiency
	Average rural household income
Increased labor productivity and reduced labor drudgery, and increased growth of agriculture sector	Average labor productivity of the main crops
	Average cost of crop establishment for the main crops
	Average time needed to establish a crop (for the main crops)
	Timeliness of main operations (planting, weeding, harvesting, threshing, shelling) for the main crops
	Time spent by women and children in manual agricultural activities
	Proportion of the energy used for farm operations coming from motorized machines
Increased rural employment	Number of service providers
	Number of local small engine mechanics
	Number of local two-wheel tractor spare part providers
	Number of local fuel and oil providers
	Number of local two-wheel tractor operators
	Number of local manufacturers

Targets/Zone of Influence

The project will be implemented in Amhara, Oromia and Tigray regions of Ethiopia (see Figure 1). The specific project sites will include Debre Birhan, Bako, Adwa and Asela where the MoANR is interested in promoting small mechanization. Small mechanization work will be promoted in Adamitulu, Arsi Negelle and Wugda because of previous work in those areas by CIMMYT and partners. Project sites will also include areas covered in the first phase and those used by sister projects such as Debre Birhan (Amhara, building on the first phase of Africa RISING), Asela (Oromia, building on FACASI), and Adwa, Bako and Debre Markos (Tigray, Oromia and Amhara, building on the GIZ project). It is projected that the project will directly reach 20000 smallholder farmers through various services from SPs during the 5 year period (see Table 1). More smallholder farmers will indirectly benefit from the project through awareness and demand creation campaigns, and field days that will be conducted in the communities around the project sites. These beneficiary farmers will be located in communities where project partners are operating in the Ethiopian highlands. Initially the project targets to start working directly with at least 60 service providers spread across the Amhara, Oromia and Tigray regions but this number will increase over the years. Given the previous experience in mechanization projects i.e. FACASI, Africa-RISING Phase 1 and GIZ, it is envisaged that SPs will provide different services depending on the demand from farmers. The number of farmers that each SP will work with will depend on the lines of business provided. Monitoring tools will be developed by project team to capture numbers of clients served by each SP. Previous experience from

the FACASI and GIZ projects has shown that each SP can serve at least 30 households when providing planting and transport services only. More service providers, as individuals or youth groups, will be trained through the GIZ and FACASI projects in the Amhara, Oromia and Tigray regions. In these sister projects Africa-RISING project will provide in-kind contribution through expertise for technical and business management training of service providers, mechanics, co-operative members and other partners. Smallholder farmers in the project target communities will also get exposed to small mechanization technologies during on-farm demonstrations of equipment use, field days, farmer meetings with different project stakeholders, and flyers that will be distributed in the 3 project regions. A total of USD615 544.40, spread over 5 years, is requested for the proposed scaling out project.

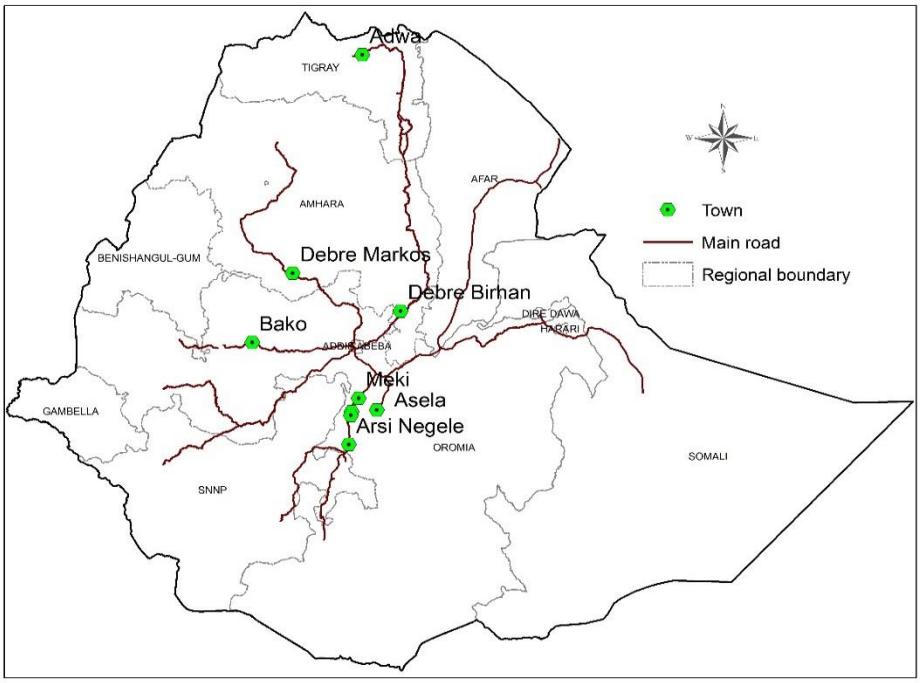


Figure 1. Some of the proposed project sites for Africa-RISING Phase 2 in the Amhara, Oromia and Tigray regions of Ethiopia

Table 1. Projected numbers of farmers that will access different services from individual and youth group service providers in the three regions of the Ethiopian highlands

Type of service	2017	2018	2019	2020	2021	TOTAL
Land preparation and planting	440	526	635	800	1052	3453
Harvesting	340	460	559	711	1039	3109
Threshing and shelling	600	790	939	1166	1608	5103
Water pumping/irrigation	100	120	150	205	260	835
Transportation	600	1000	1700	2100	2100	7500

TOTAL	2080	2896	3983	4982	6059	20000

Arrangements Required for Monitoring and Evaluation

Our M&E&L plan will be designed to collect data required to generate evidence and allow for quick feedbacks between research and development to take place in the project sites. The monitoring activities will aim at backstopping service providers and DAs working with the SPs in the different communities. During the monitoring process, what is working well or not working will be assessed and feedbacks will enable adjustments to be made in the implementation of project activities. An M & E & L framework and tools for data collection in scaling will be developed by the project team and partners at the onset of the project. Each partner will collect agreed data during the implementation of project activities. The project team will conduct training for partners on data collection using the tools developed by the project team. Data to be collected will include numbers of individual and youth group service providers, services provided by each SP, farmers receiving services from each SP for the different business lines, expenses incurred by SPs in different operations, income generated by SPs in each business line, area covered by land preparation and planting services, and crop yields. Indirect beneficiaries of the project will be tracked using procedures that will be developed by the project team. Stakeholder workshops will be conducted and during such meetings project partners will report on progress made and coverage of project activities. The use of SMS will be explored to monitor the activities of service providers, and also to improve and increase the efficiency and effectiveness of M&E&L activities. The project team will take lessons from the ATA SMS platform in order to use the SMS system for monitoring and getting feedback on small mechanization operations in the different regions.

Communications and Knowledge Management/Transfer

Various channels will be used for disseminating information about 2 WT based innovations/technologies and how the innovations are impacting on the livelihoods of smallholder farming communities in the Ethiopian highlands. A communication strategy will be developed by the project team and partners at the onset of the project. Communication pathways to be used include regular stakeholder meetings, use of SMS, on-farm technology demonstrations, field days and policy briefs based on research outcomes. Other communication strategies will be developed based on the responses/demands of technology users during the implementation of the project. Possibilities of using radio, newspapers, community meetings (at Kebele and Woreda levels) and regional exhibitions/shows for information dissemination will be explored. Scientific publications on the viability of SP business will be developed by the research team and its partners.

Outputs and Activities

The first 3 years of the project will focus more on capacity development of SPs, machine operators, mechanics and government extension staff (Training-of-Trainers) based in the different regions of Ethiopia. The last 2 years will concentrate on policy advocacy at different levels i.e. national government,

federal governments and zonal level. Generic research on technical and agri-business gaps/research questions, and market linkage related activities will be conducted throughout the 5 years of the project. The distribution of requested funds is summarized in Figure 2 below.

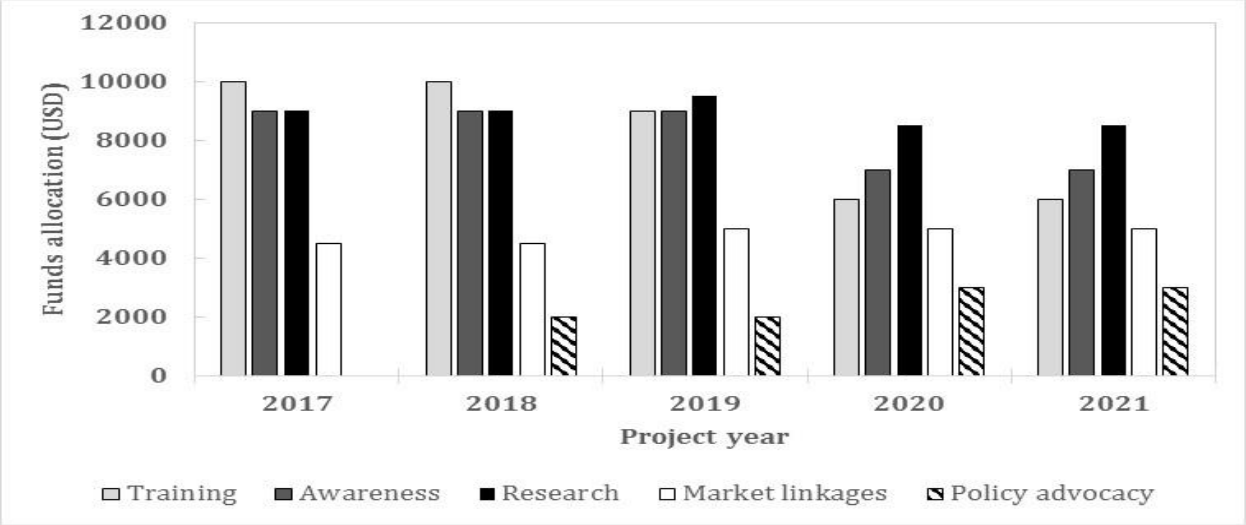


Figure 2. Expenditure of requested funds across the proposed 5 project activities in Africa-RISING Phase 2 in the Ethiopian Highlands

Output 1. Increased technical and agri-business capacity of service providers to deliver services and manage their business and extension agents to backstop SPs and farmers

Activity 1.1: Twice a year training on calibration, operations, maintenance and repair of 2 WTs and ancillary equipment in each region

Activity 1.2: Twice a year training on business and financial management in each region

Output 2. Awareness of small mechanization created at various levels

Activity 2.1: Demonstrating use of 2 WT and the available implements in project communities before the start of and during the cropping season

Activity 2.2: Farmer field days during the Belg and the Meher seasons

Activity 2.3: Annual exposure visits of smallholder farmers, DAs, local NGOs and policy makers to the project sites

Output 3: 2 WT seeded on-farm demonstrations in project communities

Activity 3.1: On-farm demonstrations seeded by rural service providers (individuals or youth groups) trained at the onset of the project. These will be paired comparisons of the same crop established conventionally and through single pass direct seeding using 2 WTs. Irrigation, threshing, shelling and transport services will also be demonstrated by the service providers.

Activity 3.2: Studies on profitability of small mechanization using different business models under the different conditions of the Ethiopian highlands

Activity 3.3: Regular mentoring/backstopping of service providers by CIMMYT and Department of Mechanization in the MoANR

Output 4. Increased market integration of importers/manufacturers and rural service providers

Activity 4.1: Roundtable meetings with importers/manufacturers for them to

understand the opportunities and the constraints faced by stakeholders downstream in the

small mechanization market system (in particular, to understand the needs of two-wheel

tractor operators and local mechanics)

Activity 4.2: Annual exposure visit of importers/manufacturers to project sites to see equipment in use and interact with SPs, local mechanics, smallholder farmers, unions and co-operatives

Output 5. Policies on mechanization of smallholder agriculture discussed and formulated with federal and national governments of Ethiopia

Activity 5.1: Workshops/round table meetings on mechanization of smallholder agriculture with policy makers at different levels, equipment manufacturers, service providers, farmer unions, co-operatives and other value chain actors

Log Frame

#	Output/Activity	Indicators	Milestone	Responsible	Due date	Risks/Assumptions
1	Increased technical and agri-business capacity of service providers to deliver services and manage their business and extension agents to backstop SPs and farmers					
1.1	Training on calibration, operations and maintenance of 2 WTs and ancillary equipment	Number of female and male participants (SPs, operators, mechanics, DAs)	Training report	CIMMYT, MoANR, Amio	Jan-Feb May-June	Stable political situation in the country
1.2	Training on business and financial management in service provision	Number of female and male participants (SPs, operators, mechanics, DAs)	Training report	CIMMYT, MoANR	Jan-Feb Aug-Sept	Stable political situation in the country

#	Output/Activity	Indicators	Milestone	Responsible	Due date	Risks/Assumptions
2	Creation of awareness/demand for mechanization					
2.1	Demonstrating use of 2 WT and the available implements in project communities before the start of and during the cropping season	Number of awareness campaigns conducted Number of female and male participants attending awareness campaigns	Reports on the equipment demonstrations conducted	CIMMYT, MoANR	Jan-Feb May-Jun Sept-Nov	Stable political situation in the project sites
2.2	Farmer field days during the Belg and the Meher seasons	Number of field days conducted Number of female and male participants	Field day reports	CIMMYT, MoANR (regional BoAs)	Mar-Apr Aug-Sept	1. Stable political situation in the project sites 2. Farmers willing to host on-farm demonstrations
2.3	Annual exposure visits of smallholder farmers, DAs, local NGOs and policy makers to the project sites	Number of visits conducted Number of female and male participants	Reports detailing sites visited, participants and issues discussed	CIMMYT, MoANR (regional BoAs)	Aug-Oct	Stable political situation in the project sites
3	2 WT seeded On-farm demonstrations in project communities					
3.1	On-farm demonstrations seeded by rural service providers trained at the onset of the project.	1. Number of on-farm demonstrations established 2. Crop yields from on-farm demonstrations	Report on demonstration establishment, management and data collected	SPs, MoANR (regional BoAs), CIMMYT	June-Nov	1. Stable political situation to allow researchers to oversee management and data collection in the project sites 2. Good rainfall pattern during

#	Output/Activity	Indicators	Milestone	Responsible	Due date	Risks/Assumptions
						growing season 3. Farmers willing to host on-farm demonstrations
3.2	Profitability studies on small mechanization under different business models	Number of business models assessed Income and expenditure of different business models studied Number of services provided by each SP	Report detailing studies conducted, data collected and the findings	CIMMYT, MoANR	Jan-Dec	Stable political situation to allow researchers to conduct studies in project sites
3.3	Regular mentoring and backstopping of service providers by CIMMYT and MoANR	Number of service providers visited	M&E&L report	CIMMYT, MoANR	Feb-Dec	Stable political situation to allow mentors to regularly visit service providers
4	Increased market integration of importers/manufacturers and rural service providers					
4.1	Roundtable meetings with importers/manufacturers for them to understand the opportunities and the constraints faced by stakeholders downstream in the small mechanization market system	Number of participants in meetings Business opportunities created for the different stakeholders	Reports detailing meetings held and issues discussed	CIMMYT, MoANR	Dec-Jan Apr-May Aug-Sept	Equipment manufacturers and importers are willing to be engaged in promoting mechanization in Ethiopia
4.2	Annual exposure visit of importers/manufacturers to project sites to see equipment in use and	Number of participants in exposure visits	Reports on visits conducted, participants and issued	CIMMYT	Apr-Jun Nov-Dec	Stable political situation to allow stakeholde

#	Output/Activity	Indicators	Milestone	Responsible	Due date	Risks/Assumptions
	interact with SPs, farmers, unions and co-operatives		discussed during visits			rs to visit project sites
5	Policies on mechanization of smallholder agriculture discussed and formulated					
5.1	Workshops/round table meetings on mechanization of smallholder agriculture with policy makers at different levels, equipment manufacturers, service providers, farmer unions, co-operatives and other value chain actors	Number of meetings conducted and participants Policy issues discussed	Workshop reports	CIMMYT	Feb-Nov	Policy makers are willing to engage with different stakeholders working on agricultural mechanization

Project staff

Name	Sex (m/f)	Agency and position	Discipline and role in project	Time input (%)	Funding
Dr. Walter Mupangwa	M	CIMMYT, Systems Agronomist	Project Leader	25	Africa-RISING
Research Associate	M/F	CIMMYT, (Local) - Agribusiness specialist	Conducting profitability studies, providing business management training to service providers, and developing business management information materials	50	Africa-RISING
Research Associate	M/F	CIMMYT, (Local) – Agronomist	Conducting agronomic studies, technical backstopping of scaling out partners, and developing technical information materials	20	Africa-RISING

Budget Breakdown

#	Category	Activity	2017	2018	2019	2020	2021
	Outputs						
1	Increased capacity of service providers to deliver services and manage their business	Activity 1.1	5000	5000	5000	3000	3000
		Activity 1.2	5000	5000	4000	3000	3000
2	Awareness of small mechanization created at various levels	Activity 2.1	3000	3000	3000	2000	2000
		Activity 2.2	4000	4000	4000	3000	3000
		Activity 2.3	2000	2000	2000	2000	2000
3	2 WT seeded on-farm demonstrations in project communities	Activity 3.1	3000	3000	3000	3000	3000
		Activity 3.2	2000	2000	3500	3500	3500
		Activity 3.3	4000	4000	3000	2000	2000
4	Increased market integration of importers/manufacturers and rural service providers	Activity 4.1	2000	2000	3000	3000	3000
		Activity 4.2	2500	2500	2000	2000	2000
5	Policies on mechanization of smallholder agriculture discussed and formulated with federal and national governments of Ethiopia	Activity 5.1	0.00	2000	2000	3000	3000
7	Project staff						
	CIMMYT Agronomist (International staff) (25%)		25000	25750	26522	27317	28136
	CIMMYT Agribusiness Specialist (Local Staff) (50%)		17500	18025	18565	19122	19696
	CIMMYT Agronomist (Local Staff) (20%)		7000	7210	7426	7649	7878
8	Travel Costs						
	Per-diems		3000	3000	3000	3000	3000
	Accommodation		4000	4000	4000	3500	3500
	Mileage		5000	5000	5000	4000	3000
9	General Supplies & Services		2000	2000	2000	2000	2000
10	Workshops (Planning and Feedback)		3000	3000	2000	2000	2000
11	Other Costs						
	Grant administration and Reporting		4392	4392	4392	4392	4392
	Audit Costs		2400	2400	2400	2400	2400
	Sub-Total		105792.00	109277.00	109805.00	104880.00	105502.00
12	Indirect Costs (15%)		15868.80	16391.55	16470.75	15732.00	15825.30
13	Total		121660.80	125668.55	126275.75	120612.00	121327.30

Creating climate-smart multifunctional landscapes through integrated soil, land and water management at different scales

Lulseged Tamene (CIAT), Kifle Woldearegay (MU), Kindu Mekonnen (ILRI), Zenebe Adimassu (IWMI)

Background and Justification

Due to population pressure and climate variability, natural resources in Ethiopia are under serious pressure. The current human and livestock population of about 100 and 150 million, respectively, pose huge pressure both on cultivated, grazing as well as other resources. Climate change, especially rainfall variability and temperature increase, is causing additional pressure on the already constrained environmental and economic resources. For instance, in 2016 over 10 Million people were in need of support because of low or in some places complete loss of crop yield caused by shortage of rains due to El-Nino. Uncertainties in climate regimes also influence how farmers make decisions, and whether they invest in necessary inputs and resources on their land. Considering the existing condition and policy environment, increasing the amount of land dedicated to agriculture to meet the increasing demand will not be possible and feasible. There is thus a need to devise multi-dimensional solutions to meet the needs of people under adverse climatic conditions. Promoting climate-smart multifunctional landscapes that can support both ecological, economic and socio-cultural benefits is the most plausible option to sustain peoples' livelihoods and economic growth while maintaining ecological stability (Scherr et al., 2012). To achieve this, landscape should be considered the operational scale because it facilitates understating and managing interactions, feedbacks and trade-offs between processes and material flows (Maginnis and Jackson, 2003). A landscape approach facilitates accounting and utilizing the diversity with landscapes through careful consideration of the spatial arrangement of landscape elements.

Our experience in phase I of Africa RISING showed that intensification at plot and farm levels can be sustainable if complemented with restoration of degraded areas through integrated land and water management practices. This is because healthy landscapes can provide a sustainable stream of ecological goods and services to the agricultural sector while proper management of agricultural activity can be critical to maintaining and restoring healthy landscapes (Fiksel, 2015). Evidences also show that sustainable land management (SLM)/soil and water conservation (SWC) and water development/management technologies can be adopted by local communities if these technologies are not only affordable but also if they can provide additional/multiple socio-economic benefits. These imply the need for integrated approaches such that landscape-farm-plot level activities and interventions are interlinked. For this, the concept of multi-functionality needs to be implemented whereby provision of ecosystem services and protection of the long-term quality of the land are achieved while enhancing agricultural production (Müller et al., 2010).

In this protocol, we will out-scale best-bet practices and approaches that can facilitate identification and implementation of site- and context-specific complementary technologies across landscapes (Fig. 1). Such practices can enhance system productivity while maintaining ecological integrity, facilitating synergies and managing tradeoffs between different uses, users and management options. Our approach will consider

the landscape in an integrated manner in order to understand interactions, feedbacks and trade-offs and develop land use plans that strike an appropriate balance between social, environmental and economic concerns. We will follow 'progressive' steps while out-scaling interventions that provide multiple benefits to multiple users and stakeholders.

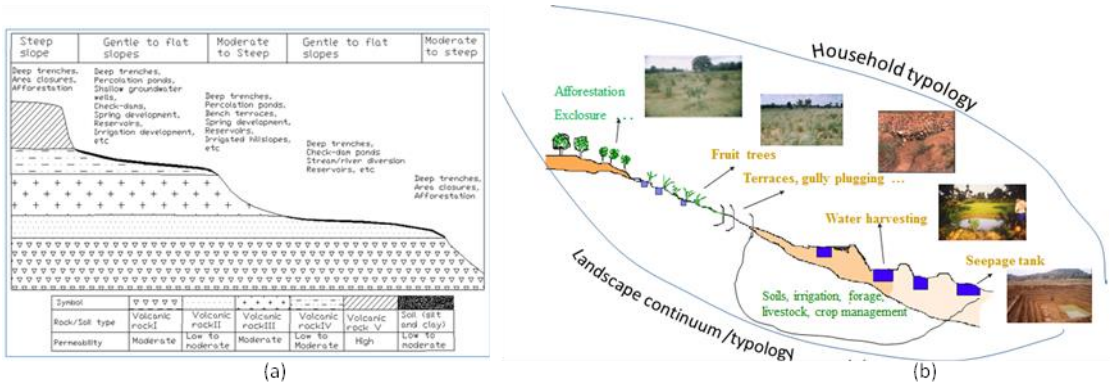


Figure 1. (a) An analytical model/framework designed to develop recommendation domains to facilitate implementing and out-scaling appropriate land and water management options (through matching option by context), and (b) site-and context-specific interventions designed considering household typology and landscape continuum (based on Desta, 2005)

Describe the nature of the innovations to be scaled

Rural communities utilize and manage the full range of land-based resources to improve food security and livelihoods. The complex interactions between different land uses and users mean that efforts to manage any of these in isolation to achieve the inter-related objectives of food security, livelihood development and environmental stability will be difficult. In an integrated landscape approach, multitude of interventions can be implemented to generate multiple benefits including restoring degraded areas, enhancing productivity, promoting resilience and increasing livelihoods and income. In this protocol, we will take stock of experiences in the first phase of the AR to out-scale proven technologies that can match to specific site conditions and can be aligned to specific household/community contexts (Fig. 1). We will follow an integrated approach whereby technologies will be prescribed following the landscape continuum and making sure that they fit to the local biophysical setting as well as to the needs and aspirations of the local communities. In addition, we will employ participatory approaches to identify which combinations of technologies placed where will be more plausible from social, economic and environmental perspective. We will develop recommendation/management domains through suitability maps that can guide spatially targeted investment planning. We will follow a progressive step from problem formulation to impacts assessment (Fig. 2) whereby year 1 interventions will fed into Year 2 and the likes. Below we present some of the best-bet technologies that will be out-scaled as they are and/or with modifications.

'Approaches/technologies'

Recommendation/management domains for targeted investment planning

SWC, SLM and water harvesting (WH) practices have been introduced in Ethiopia for long-time. The overall approach is based on a guiding manual that highlights the nature of the different technologies and how they can be implemented. Development agents and extension workers then train lead farmers within communities who will facilitate co-implementing interventions. While this is a commendable approach, there is however no detailed framework/tool that can help decide placing an intervention at a particular location. Management interventions that are intended to provide multiple functions for communities within landscapes could be sustainable if they are placed in areas they can be more effective. This requires understanding landscape biophysical conditions, requirements of interventions, societal needs and availability of adequate resources. Considering the various successful SWC/SLM/WH interventions in different part of Ethiopia, the project in Phase I has developed a generalized model that can help align a given technology or linked technologies across the landscape continuum (Fig. 1). The model is based on various geomorphological, slope, land use and climate parameters that play crucial role in designing conservation and water harvesting options. In the second phase, the model will be expanded to include socio-economic and policy variables and develop GIS-based 'recommendation/management' domains that can guide identifying and characterizing technologies to match specific socio-economic and environmental conditions. Because of gender sensitivity in technology preferences and their placement across the landscape, we will make sure that the tool considers gender and age variables. The whole process will be conducted in a participatory manner so that local constraints, opportunities, experiences, and perceptions will be taken into consideration to make the framework context-specific and applicable. The framework/model will be used when out-scaling technologies to others places or agro-ecological zones. Over the coming years the framework will continue to be improved and automated so that stakeholders can customize and apply it in their respective locations.

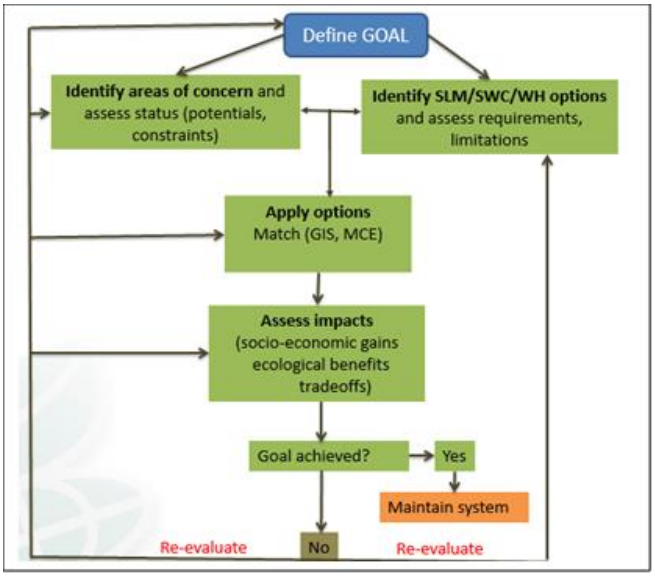


Figure 2. Key steps and activities related to landscape restoration through integrated soil, land and water management practices

Capacity development through trainings and cross-learning/exchange visits

Our Phase I experience reveals that close interaction between researchers, farmers, development partners, extension workers, administrators, and decision makers was very instrumental to create awareness and mobilize community. Evidences from phase I and elsewhere also show that trainings and experience sharing visits are very essential to create excitement and willingness to invest in landscape management technologies. As a result, co-learning 'sessions' will be organized to discuss about the best combination of technologies and their optimum placements to tackle local problems and provide multiple benefits. It is necessary to build capacity of communities, extension workers and development agents. Training packages will be designed after consulting relevant stakeholders including local communities, Bureau of Agriculture staff, extension and administrative bodies, NGO's, and private sectors. In order to deepen the trainings and knowledge base of stakeholders, exchange visits will be organized to show farmers and other relevant community representatives' real success stories in relation to integrated landscape management at different agro-ecological settings. In addition to experience sharing during trainings, active engagement of communities will help identify and select 'scalable' technologies and out-scale those to appropriate sites. The types and timings of trainings will be carefully evaluated to make sure that they accommodate gender and are given at the right season to enhance productivity and ensure sustainability.

Implementation of integrated physical and biological measures

SLM/SWC measures generally have long gestation period affecting their immediate adoption by communities. In addition, the net benefit of physical measures such as terraces, bunds and trenches will not be significant compared to the size of land taken out of cultivation. Moreover, physical measures that do not incorporate biophysical measures are found to be less resistance to erosional processes. Various evidences show that integration of biological and agronomic practices with physical SWC measures improves soil nutrient, increases crop yield and farmers' economic benefit as compared to sole physical measures (Adgo et al., 2012). The area occupied by SWC structure such as soil bunds can also be used as niche for animal feed production and integration of grasses and trees on physical SWC measures can compensates the productivity loss due to occupation of structures (Adimassu et al., 2014). Moreover, integration of trees and grasses with physical SWC structures increases the stability of the structures and hence reduces maintenance costs and enhance overall ecosystem services (Teshome et al., 2013). We will thus integrate biological options (e.g., grass strips) that can provide dual benefits such as stabilize physical SWC measures, enhance soil fertility, and provide feed for livestock. Around gullies and streams, buffers will be created using valuable plants such as bamboos, vetiver, Napier, and densho grasses. The specific technologies to be introduced will depend on 'land suitability' to match specific requirements of species to suitable landscape conditions/positions. Gender, household, and community preferences will be considered when identifying and implementing technologies.

Water resources development and management options

Climate change (especially rainfall variability and droughts) have affected crop and livestock productivity and livelihoods in Ethiopia. This has also a bearing on farmers' resilience and technology adoption as they tend to be risk averse. Water resources development and management can serve to enhance drinking and irrigation water and serve as an insurance against drought. Experiences in some parts of the country and some of the project sites demonstrate the huge benefits of water harvesting structures for human use, livestock watering and irrigation. However, small-scale irrigation is not well promoted mainly due to lack of awareness, limited technical knowhow, lack of adequate capacity to develop water harvesting schemes, lack of irrigation infrastructure, and poor water management. In the second phase, we will build on our Phase I experience to design integrated water resources management and development schemes to promote small scale irrigation. We will develop a tool that can guide placement of different water harvesting structures and estimate baseflow/water yield against the extent of area to be irrigated and/or guide irrigation scheduling. The types and location of water harvesting schemes will be defined based on comprehensive evaluation of surface/sub-surface water potential and development of water harvesting suitability maps along landscapes. We will consider the current drought in Ethiopia as an opportunity to evaluate which combinations of technologies performed better to mitigate the impacts of the observed climate change and made landscape more resilient. In order to enhance productivity and income, we will integrate high value crops, fruits, vegetables and fodder in areas where water harvesting practices are implemented. Similar to the other options, the types and placement of water harvesting structures, water lifting options and the corresponding 'crops' will consider gender dynamics.

Introduce multipurpose plant species within targeted sites

Various evidences show that introducing valuable plant species in farm plots, communal areas, enclosures and degraded sites can provide multiple socio-economic and environmental benefits. The economic benefit of enclosures, communal and degraded lands can be achieved through incorporating 'asset building' schemes such as high value fruits, fodder species, bee-hives, plants for timber and firewood and the likes. As part of this exercise, we will identify and map enclosures, communal areas and degraded sites to introduce suitable high value trees/plants. The 'varieties' will be identified such that they have high potential to provide multitude of functions including bee forage, livestock feed, human food and environmental services (incl. carbon sequestration/GHG emission reduction, soil fertility enhancement, and soil erosion reduction). The main purpose of this activity is to introduce context-specific plants and forages (grasses, legumes or shrubs) that provide economic, social, cultural and environmental services at plot, enclosure and landscape level. Ideally, a variety of plants flowering at different times of the year would be preferable. In case some of the best species are not known to the area and to the community, adaptation/screening/trial will be done for the first one to two seasons of the project implementation. On degraded areas, grasses that can stabilize the land will be introduced though their benefit for bee foraging can be minimum. Because livestock are pushed to peripheral and steep slope areas due to expansion of agriculture to grazing areas there is a need to improve feed quality at the existing small areas left for

livestock grazing and through introducing 'feed smart' SLM practices. In order to achieve these in a sustainable manner, it will be important to identify and map potential 'livestock intensification areas' and developing corresponding feed types (species). We will use GIS-approaches to define suitable areas that can be used for livestock grazing (considering the potential competition and conflict from other uses and land management practices), evaluate their suitability and identify appropriate feed varieties (fodder trees, shrubs, grasses and legumes) that can provide the best return from minimum input. This shall be integrated with small-scale irrigation using appropriate water harvesting techniques. In order to curb the food and nutrition security of smallholders and enhance income, diversification especially around homesteads will be important using 'trait-based' approach to enhance functional diversity. Because home gardens are easier to manage and more accessible to women, introducing high value crops, fruits, and vegetables will be essential to households. In order to tackle water shortage problem and sustain irrigation, roof and surface water harvesting will be implemented. This will be cross-fertilized with the ICRAF proposal.

Evidence generation

Despite some sporadic studies, there is paucity of information about the performances of the various SWC/SLM and WH measures implemented across the country. This is mainly due to the absence of adequate studies that evaluated and monitored the short-, medium-and long-term impacts and cost-benefit of interventions at farm and landscape scales. As a result, there is shortage of tangible and quantitative evidence related to the socio-economic and ecological benefits of interventions that curtailed planning and informed decision making. This can also impact technology adoption and willingness to invest. There is thus a need to generate quantitative and qualitative evidences related to the impacts of interventions at different scales using some of the following approaches.

Ex-ante analysis based on model simulation

Ex-ante analyses based on 'what-if scenarios' will be used to evaluate the potential effects of mosaics of land and water management interventions. These will be instrumental to have apriori understanding of potential effects as well as tradeoffs and design appropriate adjustments. The scenarios will show what can be achieved where through what kinds of combinations of options placed where. A participatory approach and focus group discussion will be used to 'evaluate' the results of the scenarios. Local stakeholders will also be invited to suggest different options targeted to respective hotspots and these will be tested using a modelling tool. Extension and development workers will be trained to apply the tool in their respective locations.

Quantitative assessment of impacts using measured field data

We will expand our Phase I experience and install hydrological stations and erosion plots to assess sediment and water yields at landscape and catchment scales. The results will help demonstrate the

impacts of different management practices in reducing soil erosion and enhancing water yield within landscapes. This will ultimately help create awareness and raise interest to adopt and properly manage SWC/SLM and WH practices. After quantitative data are available, the 'economics' of those interventions and their role in enhancing soil nutrients, crop yield as well as other ecosystem services will be analyzed in year II. In years III and IV, the impacts of intervention on overall ecosystem health will be assessed. The impact assessment analysis will be based on gender disaggregated data.

Evaluation based on participatory approaches and transect walks

Landscape management planning and interventions are designed to tackle problems and constraints faced by local communities. Communities along with other stakeholders are also major actors in implementing and managing those interventions. It is thus crucial to involve locals and other relevant stakeholders in designing interventions and implementing as well as evaluating their impacts. Various participatory approaches including focus group discussion (FGD), participatory rural appraisal and participatory video will be employed to identifying resources, constraints, challenges, opportunities and possible solutions as well as execute interventions and evaluate their impacts. Communities at different parts of the landscape will be brought together to discuss opportunities and challenges. The participatory forum will be designed such that different gender groups are accounted for and their voices are heard. The approach will also attempt to capture a landscape approach, illustrates dynamics in a landscape between different scales, individuals, and communities. In addition to FGD, knowledge sharing will include participatory videos, photos, interviews, and an interactive story (including map graphics) for local and external audiences. These will be complemented with field survey and transect walks so that communities and relevant stakeholders will have an objective observation of the significances or not of the various interventions.

Analysis of impacts based on process-based models

Using the ex-ante, field and participatory data collected above, we will calibrate and use hydrological models to estimate the impacts of interventions on soil nutrients, crop yields and other ecosystem services. Besides generating detailed scientific results, this approach will also be instrumental in guiding placement of best practices to enhance planning and decision making.

Further research

Sustainable management of forest/enclosure/agriculture frontier

Hundreds of millions of trees have been planted in Ethiopia as part of the extensive reforestation program in the country. Over 3 million ha of land has also been enclosed in various parts of the country. Though there are no many studies at landscape level, few have shown the contributions of such interventions in terms of enhancing soil moisture, reducing soil erosion and enhancing biodiversity. However, field level assessments indicate that the conservation and reforestation works are taken with little emphasis on the

needs of the agricultural sector and economic interest of communities. There are also no clear modalities about the responsibility and benefit sharing by different stakeholders. There are evidences that reforestation (including area enclosures) can be better planned and implemented to make these areas sources of fodder, wood and food if certain technical and institutional challenges are addressed. In addition, it is useful to consider careful selection of sites for ex-closures, defining their objectives, selecting innovations and management plans that would help achieve negotiated objectives, clarifying tenure, and agreeing on responsibility and benefit sharing mechanisms between managing communities and other stakeholders. In this project, we will work towards designing framework that can demonstrate how the forest/enclosure-agriculture sectors work in complementary than competitive manner. This is simply because the future of forests, agriculture/food and climate are so interlinked that achieving one objective without the other cannot be considered effective and efficient (as it leads to more trade-offs).

Insurance schemes – value creation – payment for ecosystem services

SWC and SLM practices generally have long-term economic benefits for farmers. As a result, their adoptions may be limited as they do not answer the farmers' immediate needs. Various efforts have been made to create incentives for the communities to participate in SWC and SLM practices. Some of the efforts such as allowing farmers to get livestock feed from enclosures (cut- and carry- system) is appreciated but is also reported to have less return than expected (Seyoum et al., 2015). Recently, efforts are being made to integrate SLM options with more income generating schemes such as beehives, high value trees, allocating benches to the youth and the landless, etc. While these options are commendable, it is not yet clear if these incentives could encourage wider adoption of SWC and SLM practices. Experiences elsewhere (e.g. in Latin America) suggest that designing tailored and negotiated mechanisms of payment for eco-system services may be an option. For example, it can be possible to introduce modalities whereby those who planted trees and properly manage them can receive $ credit (bonus) while those who integrated planting trees with energy saving stoves can get $+x credit. The details can be worked out based on the benefits downstream farmers get and their willingness and capacity to pay. The challenge and focus will be on identifying those who should pay for the bonuses and negotiating payment schemes. Generally, the payment can be made by government, NGOs, private sectors and community members. The form of payment can be in monetary form, waving some payments the farmers were supposed to get, allowing them to access credit with low interest rate, payment for children school, free medical care and the likes. We will draw experiences from some countries to design modalities to create conditions such that those who manage their localities will be reimbursed for their efforts in ensuring sustainable flow of ecosystem services. The framework will also be instrumental in enhancing the reporting and/or negotiation power of developing countries against payment for the extent of areas restored.

Decision support system for integrated ecosystem health assessment

Landscapes are increasingly being used simultaneously for several purposes causing pressure, conflict over use, and miss-management ultimately affecting their productivity and performances. By providing

system level understanding of the various processes and their interactions, it will be useful to develop GIS-based resource management domains and corresponding management strategies. Such tools can facilitate ecological intensification through spatial optimization of landscapes base on 'customized' strategies that can help match options to contexts. This can also enhance conducting suitability analysis and land use planning for spatially targeting of investments. Through the above subsequent steps, frameworks, tools and 'business plan' will be developed to facilitate implementing complementary technologies considering landscape and household conditions. In order to facilitate targeting and detailed analysis of the economic, social, ecological, and cultural impacts (including cost-benefit, synergies complementarities, and trade-offs) of the various interventions and facilitate appropriate out- and/or-up scaling, an integrated decision support system (DSS) will be developed. The DSS will integrate different biophysical and social-economic attributes, land use and management components, as well as climate policy, institution and market scenarios. At the end of the project, the DSS should be able to estimate the overall ecosystem health of study sites.

Benefits

Through creating climate-smart multifunctional landscapes, it is clear that multitude of benefits will be generated. Soil erosion, flooding, siltation of irrigation infrastructures will significantly reduce. From the fruits and vegetables around homesteads as well as irrigation, human nutrition and income will be improved. Because of the availability of feed for livestock and fuel energy, overgrazing, conflict over land use (cultivation versus livestock) and deforestation will reduce. Ultimately, overall system productivity and livelihoods will be improved and the resilience to shocks of households enhanced. As the options are implemented at landscape level, ecosystem services will also improve.

Due to improved watershed management, sediment yield will significantly reduce and its impacts on downstream hydro-electric power stations will be minimized. The options, frameworks and tools will improve the sustainable management and utilization of the reconnaissance dam and others in the country. This can improve growth and development due to avoidance of frequent power cuts.

Lessons shall be learned from drought resilient landscapes created over the years for further upscaling to other sites. The idea of multifunctional and climate-smart landscapes will be incorporated into the Ethiopian government strategies. With this, spatially targeted investments in agriculture can be linked to payment for ecosystem services (PES) schemes. On the other hand, incentive mechanisms for agricultural products that further enhance ecological management and climate resilience will be facilitated. With these the 'landscapes' and 'farm-plot' level interventions will complement each other. This will facilitate synergy, reduce trade-offs and ultimately sustain interventions. Additionally, communities will be aware of the various technologies and benefit from their widespread use. This will promote adoption and out-scaling for enhancing food security under rainfall variability.

In the long-run, the various interventions will improve carbon sequestration and reduce GHG emission. Farmers and communities can benefit from 'payment for environmental services' for their role in sequestering carbon and/or reducing GHG emission. With the relevant tools and approaches to quantify

and generate evidences, the country will benefits from payments for its contribution towards 'land degradation neutrality'.

The participatory approaches implemented will create awareness to local communities and policy makers within and beyond the implementation landscapes. It will also serve as a basis to stimulate other locations to where out-scaling will be intended.

The DSS developed to guide targeted intervention will facilitate identification and implementation of suitable management options to specific landscapes and household conditions. It will also help evaluate cost-benefit and trade-offs of interventions.

Research Questions

- Where the major are land degradation hotspots, what are the major drivers and associated effects at different scales?
- What are the existing conditions (potentials and constraints) of the study landscapes, their requirements for improvements and what do the socio-economic constituencies of communities look like?
- Which watersheds are more resilient to droughts than others and why?
- What should be the investment direction with regard to SLM/SWC and water harvesting of small-holder farmers under changing climate?
- What combination of 'technologies' placed in which position of the landscape would maximize the foreseen environmental and livelihood benefits and promote multifunctional landscapes?
- What are the benefits, opportunities and possible trade-offs of implementing complementary and supplementary technologies at different scales?
- What kinds of institutional set-ups/bi-laws as well as policy/institutional incentives are needed to both promote technology adoption and sustain their implementation and benefits?
- What are the constraints for technology adoption and what incentives can promote adoption and sustainable management?
- What are the 'economics' of SLM, SWC, and water harvesting options implemented at different scales?
- What kinds of PES frameworks can be designed to incentivize and reward those who implement integrated watershed management practices?

Development Partnerships

Existing partners

An important pre-requisite of integrated landscape management is to recognize the fact that it requires (multi)-interdisciplinary approach, should focus on achieving overall system productivity and involves multi-scale research and outreach to ensure sustainability. Landscapes are "social constructs" that may not be bounded within the same administrative unit. As a result, broad cross-sector coordination and collaboration to facilitate collective action of major stakeholders are needed to achieve long-term impacts in a sustainable manner. Partnership and institutional and policy support at different levels are thus

necessary. Cognizant of this and the relevance of the project, we have collaborated with various partners in phase I and will continue to do so in phase II.

In phase one of the project, we have successfully collaborated with the local community, Bureau of Agriculture, research centers and Universities. The local communities were the major actors who implemented the various technologies. The Bureau of Agriculture was instrumental in mobilizing communities and facilitating implementation of technologies. The research centers helped in managing soil and water sample preparation and analysis of samples. The Universities provided technical inputs and hosted PhD and MSc students. It is also worth to mention that local level administration (Kebele and Woreda levels) played pivotal role in mobilizing communities, creating awareness and supporting the project in various forms. Finally, the Kebele IPs were key not only in commenting on protocols and the approaches but also 'evaluating' the processes of implementation and the outputs. This helped for designing context-specific and problem-oriented protocols. In order to out-scale climate-smart technologies across wider-areas, partnership and support from various actors is necessary. As a result, we explored the various institutions with common interest and who can help out-scaling interventions in Phase II (Table 1).

New partners

The SLM program of the Bureau of Agriculture and Rural Development (in the different regions) and the Ministry of Agriculture are interested to collaborate with the project as they also implement SLM practices across selected watersheds. Our discussion with the Amhara region Agriculture Bureau Natural Resources Directorate indicated willingness to link with SLM, Safety Net and MERET programs, which will enable out-scaling Africa RISING technologies, tools and experiences. We have also agreed to synchronize our sites with those of SLM and other development projects (by various donors, NGO's, and government) so that we co-invest and share experiences. Through our partner, Mekelle University, we have received confirmation that SLM (district level) will be willing to foster collocation with us in some of their watersheds in South Wollo Zone. They are prepared to invest to implement practices and will be happy to get technical advice and training as well as some inputs from the project. We made discussions to integrate our interventions with those of ICIPE sites (focused on bee-forages) in the Amhara region. The Bureau of Agriculture and Rural Development of Tigray region, and one of the Relief Society of Tigray (REST) have also shown their great interest to work with the project in upscaling activities. The Wurko St. Mary in Tigray also agreed to co-invest in integrated land and water management in some of their sites. Recently, we discussed with EIAR Integrated Watershed Management Research Team leader and there is an overall agreement to collaborate on technology out-scaling whereby we will provide support on evidence generation in some of their watersheds. Some NGOS such as InterAid France and the Catholic Church in the SNNP are very much interested to collaborate with our project. We are designing detailed framework of implementation. Based on our discussion on joint implementation of SWC/SLM interventions, the GIZ could be another partner which will collaborate and co-invest implementing our protocols.

Table 1. Partners who will be associated with the 'integrated landscape' management protocol of the Africa RISING project in the highlands of Ethiopia

Partner	Contribution	Africa RISING	Advantage
CG centres: CIAT, CIFOR, ICRAF, ILRI, IWMI	Complementarity, technology/option, staff time, implementation, monitoring and evaluation, reporting	Technical input, capacity development, fund for staff time and operations	Facilitates experience sharing and out-reach, provides comparative advantage for each
ICIPE	Funding for bee-forge trials and mobilize communities	Technical support on suitable and multipurpose bee-forage varieties	Co-investment, capacity exchange and project sustainability
MoA: - SLM, PSNP, AGP, MERET	Facilitate scaling out-/up the new technologies, provide inputs when necessary	Technical support, capacity development, evidence generation, input when needed	Synergy and co-investment, experience sharing, government buy-in will enhances sustainability
MoEFCC: - CRGE	Facilitates implementation as they have 'restoration' targets' (22 million)	Proven integrated (complementary/linked) technologies, monitoring and evaluation	Synergy and co-investment, experience sharing, government buy-in will enhances sustainability
GIZ: - SLM	Technical exchanges, capacity + scale-up on their watersheds	Co-invest and share experiences	Co-investment, technical experience sharing, out-scaling
Regional Bureau of Agriculture: Amhara, Tigray, SNNP, Oromia	Help implement integrated land and water conservation practices on the ground, help manage interventions	Capacity building, input of different forms, specifically seeds (crops, forages, and grasses), and evidence generation	Facilitate implementing at scale
Regional Research Institutes	Provide evidence on what works and doesn't work, where and why, be partners and implementers, help sample analysis	Proven technologies, resources, capacity building, evidence generation	Partial co-investment as they provide technical, material (lab, labour) support, out- and up-scaling, monitoring and evaluation
Universities:	Implementation support, capacity building, and undertake research (involving students)	Funds for capacity, research and technical support	Partial co-investment, proven scientific products including tools, frameworks, local capacity building, etc.
NGOs: - REST - Wukro Saint Marry, InterAid, Catholic Church	Spread technology - outputs to impacts, linkages with communities, provide inputs, exchange skills	Technology, capacity building, evidence generation, inputs, scale their technologies	Co-investments, facilitate dissemination of technologies, provide inputs, share cost of experience sharing/ trainings
Kebele admin. and communities	Mobilize communities, implement and manage technologies	Capacity building, support for seeds, evidence generation	Implement interventions at scale, contribute to participatory planning, evaluation
Private sectors	Support create market to agricultural products and help implement the technologies	Capacity building, and evidence generation	Create market to products and involve in the implementation of the innovations

Impact Pathway

Table 2. Major activities, outputs and outcomes of the 'integrated landscape management' protocol of the Africa RISING project in the highlands of Ethiopia

Activities	Outputs	Outcomes	Impacts
Workshops, field visits	Policy briefs, guidelines, toolkits … developed	Policy makers adjusted their policies … towards multifunctional landscapes	Improved knowledge management
Review, collate and analyse (meta-data); implement SWC, SLM, WH technologies; establish demonstration sites/plots at different scales; analyze data	Datasets and database available; complementary/linked technologies tested, validated, and documented; guidelines for implementation developed; over 5000 ha of land covered with SWC/SLM interventions (year 2017)	Households adopted best-bet technologies; NGOS and partners used our frameworks and tools; planners and policy makers become aware of the benefits of linked technologies	Improved overall system productivity, (due to climate-smart landscapes); ecosystem health improved
Field and exchange visits	Horizontal learning and co-learning	Communities developed confidence in implementing interventions	Multiple benefits from multiple options
Situation analysis and contextualize; estimate, measure, model; scenario, ex-ante analysis; out-scale best-bet technologies	Severity of erosion estimated, hotspot areas of intervention mapped and suitable management measures identified; water yield availability (soil moisture) estimated; tools to augment water use developed); carbon sequestration potential of different land use and management options estimated	Communities, government and NGOs showed interest in our linked technologies because of evidences of reduced deforestation, soil loss, stabilized HEP through reduced siltation and energy efficient options; improved overall soil health and biodiversity and enhanced provisioning and regulating services of landscapes	Improved cross-boundary benefits of ecosystem services
Diversify income generating activities; create nutrition sensitive landscapes; map 'specialized' areas	Biodiverse and nutritious food and feed available; appropriate and productive varieties identified and released; bee keeping promoted; forage, timber, fuel wood, construction materials available	About 25% of six landscapes targeted with mosaics of interventions; deforestation decreased by 60%; household income increased (25%) due to interventions; livelihoods of around 5000 people	Livelihood, food security, nutrition of household improved

Activities	Outputs	Outcomes	Impacts
		improved (nutrition, food diversity, etc.);	
GIS-based tools; frameworks; guides; publications	Contribute to validation and testing tools, frameworks	Policy makers and planners able to make informed decisions	Capacity/ efficiently of targeting/impact assessment improved
Cost-benefit, trade-offs analysis	Economics of interventions estimated; trade-offs and synergies determined	Government, planners, communities able to make informed decisions	Contributions of interventions determined

Targets / Zone of Influence

Integrated landscape management aimed to create climate-smart multifunctional landscapes will require resources, manpower and demands time. It also needs political and institutional support especially when landscapes transcend multiple administrative boundaries. The 'success' thus depends on how the above function properly. Generally, we will be out-scaling proven technologies and anticipate to work closely with governmental and non-governmental organizations.

Initially, we will consolidate our interventions in the four regions of Africa RISING sites (Tigray, Amhara, Oromia and SNNP; Table 3). We will implement the various practices in one additional watershed to the existing ones. We will then add two other watersheds in each region aligned to SLM, GIZ, InterAid, Catholic, and other partners' watersheds. Over the five years we will ultimately reach approximately 42 watersheds (Table 3). Within each watershed, we will consider landscapes of around 1,000 ha where the integrated practices will be implemented. With this, we will cover about 42,000 ha of land. Considering average land holding in Amhara, Tigray, SNNPR and Oromia is 0.75, 0.54, 0.89 and 1.15 ha, respectively (Nega et al., 2003), there will be about 51,027 direct beneficiary households.

We assume that there will be multiplier and off-site effects in the neighbouring and other government/NGO-led and community-based watersheds. Considering that the Government of Ethiopia aims to target implementing watershed management practices at one watershed per Kebele, we identified about 9365 Kebeles within the highlands (between 2000 – 3000 m.a.s.l. where AR will operate) of the four major regions that can potentially be influenced by government interventions. As our interventions will focus on ten zones in the four regions (three in Amhara, three in Oromia, three in SNNPR, two in Tigray region) and the average land holding size in each region, there will be about 2,768,380 households of secondary beneficiaries (Table 3). This also hypothesizes that there will be complementarity between our and government/NGO-led interventions, thus the potential number of beneficiaries can be higher.

Table 1. Targeted and potential beneficiary households for landscape management innovations.

Region	Number of watersheds	Total land area (ha)	Directly engaged households	Potential beneficiaries in ZoI
Amhara	12	12,000	16,000	768,750
Oromia	12	12,000	10,434	1,407,600
SNNPR	12	12,000	13,482	527,770
Tigray	6	6,000	11,111	64,260
Total	42	42,000	51,027	2,768,380

Arrangements Required for Monitoring and Evaluation

- In order to make sure that our impacts are captured, we will conduct detailed situation analysis which will provide the 'current' condition (baseline) of the study site and the database will be used to define recommendation domains – define potential areas towards which 'similar' technologies can be out-scaled. There will then be regular monitoring of 'situations' and make recordings against the baseline. In order to facilitate this, the followed will be ensured:
- Geo-locate sites and data collection points as well as households
- Prepare data recording sheet, provide training to those who will collect data
- Conduct field visits and participatory discussions of changes
- Conduct quantitative measurements
- Integrate data in a database and data management
- Organize different platforms for cross-learning and evaluation
- Use the recently developed SI indicators (productivity, environment, economic, social, human) to monitor changes and assess impacts
- Collaborate with M&E experts
- Use the beneficiary tracking system that will be in place to capture formal and informal dissemination of technologies and practices.

Capacity Development – what and, possibly, how?

Capacity development (CD) effort will focus on various stakeholders at different levels (examples are mentioned below). Training manuals and relevant materials will be developed to facilitate and sustain the CD activities.

- Participatory identification and design of interventions. The key problems/constraints and appropriate solutions will be identified and designed in a participatory manner. This will make the project activities demand-driven and facilitate adoption.
- Design relevant learning materials and approaches. Based on the needs assessment and observed constraints, adequate and application training materials will be prepared (considering the levels of stakeholders under consideration). AR team members and other relevant experts to specific fields will be involved in designing training materials and executing trainings.
- Organize exchange and cross-learning visits. These were one of the best interventions experienced under phase one of the SLM/SWC exercise. These enabled first hand observation of successes cases and discuss challenges and rectification methods. This will be strengthened under

Phase II. The visits will be designed to be inter and intra. Discussions will be held with respective stakeholders the kids of gaps to be filled and sites to visit.

- On-site/practical experience sharing. Discussions and awareness creation will be conducted to identify which combinations of options placed where (in what spatial and temporal arrangement) can provide maximum benefits. This will be done during technology identification but mainly during implementation. Joint assessment of the status of interventions will also be conducted at least once a year, to learn lessons to adapt improvements for the coming seasons.
- Co-learn with farmers, Kebele/district/zonal level BoA and research centres staffs and administrators. Our experience in phase I demonstrated that trainings involving different actors at different levels will be crucial to advance understanding and enhance sustainability. Based on initial need assessment, trainings will be provided to various stakeholder at different levels.
- Trainings at MSc and PhD levels: Embed masters and PhD students to generate primary data and scientific results. These will also help advance AR project findings at national, regional and international levels.

Gender

Generally, women and women-headed households are constrained in terms of resource access and use. On the other hand, there are specific roles women play in the household and designing interventions that can enhance those roles could benefit women. It will thus be essential to carefully consider the needs and cultural issues of the different sites when selecting, packaging and implementing interventions. It is also necessary to consider gender while identifying, designing and executing interventions. It is generally believed that introduction of improved technologies specifically related to water harvesting, beehives, livestock feed as well as home gardens will increase women's benefits because of their differential roles to men. If water harvesting options and water lifting technologies consider gender, women can benefit better as it reduces travel time to fetch water. As it is generally women who manage home garden and use of fruits/vegetables, there is also a higher impact on women. Empowering women is also instrumental to promote nutrition at household levels. Gender disaggregated data will be collected to understand the variation of impacts of interventions. We will study the impacts through disaggregated analysis of the roles of men and women in the management, utilization and decision making related to the inputs and products of the various interventions. AR gender specialist and others who have adequate knowledge will be used to create awareness and develop strategies to rectifying gender-based constraints. They will also help gender disaggregated data acquisition and analysis.

Communications and Knowledge Management /Transfer

The formats, platforms and avenues as well as media of communication of technologies and results will be partner specific and thus client oriented. Generally, the following structures and/or formats will be used to communicate and knowledge management.

- Local structures (traditional and governmental); workshop; database; policy briefs; policy dialogue; proceedings; technical reports; documents (publications); website (online materials); documentary videos; farm Radio; farmer field school; field days and visits; exchange visits (cross-

learning) events; schools (elementary and high schools given briefs and seminars); use of media (radio and TV).

Key activities and deliverables in 2017

Table 4. Major activities and deliverables until October 2017 season.

Activity	Deliverable	Lead
Situation analysis of new sites	Report with data	Dr. Lulseged T.
Mapping land degradation hotspots and prioritization of intervention areas	Hotspot maps, reports on prioritized areas	Dr. Lulseged
Evaluate water resources and implement suitable WH options in three sites	Water harvesting suitability maps, reports with Photos	Dr. Kifle
Install and monitor erosion plots and hydrological station in three sites	Photos, data, report, paper for publication	Dr. Lulseged/Wuletawu
Introduce suitable forages on terraces, trenches, enclosures, degraded areas and monitor performance	Photos, data, reports, paper for publication	Dr. Kindu
Define criteria to identify indicators of resilient watersheds to climate change	Data, report, paper draft for publication	Drs. Kifle/Wuletawu
Define what technologies placed where offer best-bet impacts for different users	Framework, report, paper draft	Team
Review possible modalities on payment for environmental services	Review paper	Drs. Lulseged/Wuletawu
Developing approaches to scale SLM options	Report, draft for publication	Dr. Wuletawu
Database for impact assessment and monitoring	Data, database, meta-data	Drs. Lulseged/Wuletawu
Training, capacity development	Training material, report	Team
Presentation in scientific forum	Report, Abstract, Poster, ppt.	Team
Coordinate project implementation, monitoring and report	Report	Dr. Lulseged

Budget Details

Indicative budget - by activity until September 2017 at least

Table 5 presents budget estimate for the implementation (mainly scaling) of technologies in at least six sites of the four major regions (Amhara, Tigray, Oromia and SNNP). The budget is based on project contributions related to basic staff time (for those who will be involved but not have their own budget), basic inputs (mainly seeds, pump to demonstrate water harvesting in Debrebirhan), exchange visits,

trainings and capacity development. The majority of the partners (e.g., St. Marry in Tigray and ICIPE) will work with us at relatively no cost for inputs. For the others, there is a need for the project to 'share cost' for key inputs in addition to contribution for exchange visit and capacity development.

Figures in USD$ 160590.00

Item	Budget (USD)	Remark
Personnel		
Lulseged Tamene (CIAT)	49,200	
Staff time (Wuletawu, Fred)	12,500	
Research assistant (CIAT)	9,000	
Sub Total	70,700	
Supplies and Service		
Staff time (Mekelle University) -	12,000	
ARARI Soil and Water Directorate	10,000	
ARARI, Forestry Research Directorate	3,000	
Basic seed (livestock forage, bee-forage, crop) to	6,757	
Nursery establishment in two sites	2,000	
Training and capacity development (two sites)	4,000	
Erosion plot (install, collect data, manage) at three sites with 5 treatments and 2 replications	10,078	
Sampling and sediment and soil nutrient analysis in three sites	357	
High resolution satellite images and processing the images	2, 500	
Gauging station for watershed level sediment monitoring	2,049	
GPS	300	
Vehicle mileage to cover study sites at different times of data collection	4,000	
Vehicle fuel	1,200	
Office facilities	1,500	
Communication	500	
Printing	300	
Sub Total	60,541	
Travel		
Travel for workshops, conferences etc.	5, 000	
NRS, BoA, MoA Process owners	1,800	
Per diem (four people) for 20 days	3,200	
Accommodation (four people) for 20 days	2,143	
Sub Total	12,143	
Sub-total	143,384	

Item	Budget (USD)	Remark
Overhead 12%	17,206	
Total	160,590	

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Scaling up high value multipurpose trees and their management practices from homestead to landscape

ICRAF

Activities

- Identified and create a taskforce of local partners (government, private, NGOs) for scaling up high value tree in four regions
- Provided Training of Trainers in high value trees in four woredas
- Prepared training materials and provided to the trainees
- Provided seed to Shaya nursery
- Performance of the high value trees monitored
- Mobilized local communities' farmers and governments to scale up high value trees

Budget

S.No	Explanation (type of costs)	Total
1	personnel	21,943.00
2	B. Supplies and Service	1,146.00
3	C. Operational Travel	3,853.00
Total direct costs		26,942.00
Indirect costs (15%)		4,041.00
TOTAL		30,983.00

Title: Scaling up/out of Enset research technologies through Integrated Disease and Pest Management (IPM) approaches

Background and Justification

Enset (*Ensete ventricosum* (Welw.) Cheesman) is a multi-purpose plant with a range of utilities including food, feed, construction and medicinal uses. The production of enset in Ethiopia threatened by Enset bacterial wilt disease (EBW) caused by *Xanthomonas campestris* pv. *musacearum*. It is a major constraint to enset production in Ethiopia, endangering the livelihoods of millions of farmers and threatening the food security of over 20 million people for whom enset is a staple food. In recent years, EBW has pushed farmers to reduce significantly enset cultivation, causing changes in cropping systems and dietary practices in enset growing areas. Of the diseases and pests facing farmers in enset producing areas— EBW, enset root mealy bug, leaf hopper, mole rat, porcupine, wild pigs, corm rot, and drought—EBW has had the greatest impact on enset production.

There are also good opportunities like well-established enset farming system, farmers' knowledge on use value based management of enset diversity, the presence of different cultivars that show differential response for the disease, established partnership on bacterial wilt eradication, government structure and 1 to 5 group organizations at a grass root level, and good governance for mass mobilization to control EBW.

With the above-mentioned consequence, different improved IDM management options had been demonstrated in selected sites in different agro-ecologies. The improved technologies are improved varieties demonstration, and awareness creation and community mobilization for the control of EBW disease.

Distribution of released and recommended enset varieties:

Enset research project gave more focus on germplasm collection, maintenance, and evaluation for release and agronomic aspects and community based integrated disease management aspects. On account of such efforts, about 700 enset landraces has been collected and maintained in field gene bank of Areka. Six enset varieties and one disease tolerant variety released and recommended for their earliness, high kocho yield and disease tolerant. More than 600,000 suckers of released enset varieties with the help of FAO and other stakeholders were distributed to farmers, and seed producers of SNNPRs. Moreover, recently recommended disease tolerant clone Mazia, was multiplied at the benchmark site or kebele and distributed to 265 farmers, 40 suckers for each and a total of 10,520 suckers were delivered. Farmers are advised to incorporate these clones into their diversity. More demand for improved production technologies (improved planting material) and collaboration is created.

Community Based Integrated Management of Bacterial Wilt of Enset:

Community mobilization and collective action approach were conducted followed by raising farmers' awareness about EBW cause, transmission, control and prevention means along with all other improved enset production and disease/pest management practices. Before the start of the intervention a base line

was carried out in the selected woredas. Sample respondents claimed that about 25.6 % of farmers' field was infected by the disease in 2007 and the level reached 54.5% in 2010. This was the time when intervention demanded by the farmers and various partners were convinced to intervene, resource was allocated, and partners shares roles and responsibilities. Researchers' team composed of different discipline had given the assignment to own and conduct in close collaboration with Bureau of Agriculture and local government authorities. Systematic awareness creation (using print material (Manual, Poster and leaflets) and local media) and large-scale community mobilization program carried out at benchmark sites of six zones to synthesize enset farming communities and arrest the damaging effect of the deadly enset disease enset bacterial wilt. After the intervention, end line assessment was carried out with the objective to see the change after the intervention. The survey shown the disease prevalence declined to 10 percent in 2013. Disease incidence has shown that the intensity was highest in 2010; that is on average more than 15 enset were infected by the disease and shown significant decline in 2013 to about 1 infected enset on the infected fields. The intervention brought about promising step-ups in controlling the devastation by EBW. This intervention demonstrated that the disease impact can be minimized to a significant level if community mobilization and collective action approach with other local formal and informal institutions go hand in hand to out scale the experience to a wider range of enset farming communities.

Because of these movements, more demand for improved production technologies and collaboration is coming onboard. Multiparty planning, implementation, evaluation and adoption of new technologies have led to the significant growth in enset production. At this time farmers in enset producing and non-producing areas shows great interest to bring the crops on their farm field. In general, the project has shown highly promising results which need to be consolidated and disseminated through further support from the Africa RISING project in the coming years. Therefore, this project is initiated with the objectives indicated below:

Objectives

General objective

The project, in just over a year of its operation, has displayed encouraging results, which need to be amplified and extended. The overall objective of the project is to increase incomes and livelihood of smallholder farmers in enset-based farming system through integrated management of EBW.

Specific objectives are to:

- To multiply and scale up improved enset planting material.
- Scale out integrated enset bacterial wilt management interventions to enset farmers and farming communities
- Continue participatory variety selection of enset clones that combine high yield, disease resistance/tolerance and culinary traits.
- Strengthen innovative informal seed system for quality planting material multiplication.
- Strengthen the capacity of enset farming communities (especially women), DAs, extension staffs, private planting material multipliers and collaborating institutions.

Study the adoption and impacts of the scale up approaches

Benefits

The benefits from this scaling out of the project will be:

- Smallholder farmers (male and female) will benefit from increased productivity and increase incomes
- Farmers, extension staff and researchers' knowledge/skills increased during the implementation of the project
- Planting material will be easily available, and growers will benefit from planting material sales.
- More enset product will be available for local markets and the increased incomes will benefit farmers by improving their quality of life.
- Good linkages among stakeholders in the project areas to promote new technologies, knowledge/information and skills will be created

Research Questions

- What strategies are most effective for improving access to and capacity to use improved enset technologies and other information by smallholder farmers especially women to achieve sustainable EBW disease management?
- What existing and novel community organizational and administrative structures could be deployed and enset bacterial wilt alert (early warning and action) system put in place to enhance community action and control the disease in the zone?

Development Partnerships

Partners that will contribute to the success of the project

1. **Southern Agricultural Research Institute (SARI)**: will coordinate the overall planning and implementation of the project. In addition, the institute will lead demonstration and dissemination of integrated bacterial wilt control measures through collective action, monitoring and evaluation through workshops, seminars, experience sharing, and reporting. The institute will also provide financial and technical support for material multiplication, distribution and local stakeholders' capacity building via short term training.
2. **Areka Agricultural Research Center (Areka ARC)**: Areka ARC (which is under SARI) is the coordinator of the National Enset Research Project in Ethiopia. The center will involve in large scale improved planting material multiplication and distribution, demonstration and dissemination of integrated bacterial wilt control measures through collective action, monitoring and evaluation through workshops, seminars, experience sharing, and reporting.
3. **Wachamo University (WU)**: will involve in large scale improved planting material multiplication and distribution, demonstration and dissemination of integrated bacterial wilt control measures through collective action, monitoring and evaluation through workshops, seminars, experience sharing, and reporting.

4. **Hadiya zone Bureau of Agriculture (BoA)**: The BoA will involve in, demonstration and dissemination of integrated bacterial wilt control measures through collective action, monitoring and evaluation through workshops, seminars, experience sharing, and reporting. The office is the main partners/collaborators in the management of the wilt disease through collective action and community mobilization.
5. **Africa RISING**: Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base. With this goal the program will involve in research in development activities, networking with other international institutions, knowledge sharing through field day, workshops, experience sharing visits. The program will also participate in capacity building of partner institutions and financial support for scaling up activities.
6. **Bioversity International**: is a global research-for-development organization that envisions agricultural biodiversity nourishing people and sustaining the planet. It delivers technical support like promotional material preparation (Video, Poster and leaflet) management practices and policy options to use and safeguard agricultural biodiversity to attain sustainable global food and nutrition security.
7. **Farm Radio International**: is a not-for-profit organization working in direct partnership with approximately 400 radio broadcasters in 38 African countries to fight poverty and food insecurity. Farm Radio International helps female and male small-scale farmers to gain access to up-to-date research results, appropriate knowledge, methodologies, information and technologies. This information will be communicated and discussed through effective and accurate radio programs that value farmers respond to their information needs, are broadcast consistently at convenient times, and are entertaining.

Impact Pathway

#	Activities	Outputs	Outcomes	Impacts
1	Large scale demonstration and dissemination of integrated enset bacterial wilt control measures Multiplication and distribution of released and recommended enset varieties Evaluation & documentation of collective action approaches for EBW management	Integrated disease management strategies demonstrated & disseminated Farmers' selected varieties scaled up Capacity building of farmers, development agents and extension experts Effectiveness of collective action for EBW management documented and workable approaches recommended	Less incidence of bacterial wilt in AR Sites and beyond. EXW management strategies developed and implemented. Enhanced IDM technologies diffused Awareness created on the means of disease transmission & control	Increased production & productivity Enhanced food and income security of enset farmers

#	Activities	Outputs	Outcomes	Impacts
2	Participatory variety selection of disease tolerant and high yielding enset varieties	Clones suitable for different use value identified	EXW incidence Reduced Minimized genetic erosion through in situ conservation	Increased production & productivity Enhanced food and income security of enset farmers
3	Demonstration of improved enset processing devices	Enset processing devices demonstrated	Workload of women farmers reduced	Increased production & productivity Enhanced food and income security of enset farmers
4	Enhance the skills and knowledge of women farmers on principles and methods of enset product preparation	The skill and knowledge of women farmers on improved enset product preparation enhanced. Value added products available.	Women knowledge and role for enset management and maintenance and value-added product preparation improved and EBW disease incidence reduced Income from sale of enset product improved.	Increased production & productivity Enhanced food and income security of enset farmers
5	Identify challenge, determinants, intensity and opportunity of adopting improved enset production technologies	The level and intensity of adoption and impact of improved enset production technologies analyzed	Policy issues suggested	Increased production & productivity Enhanced food and income security of enset farmers
6	Organize short-term training on large scale PVS data management and analysis, variety screening, integrated crop management data arrangement and analysis, quality analysis and technology transfer Identify and provide critical facilities required for research centre, University, and BOA,	Capacity of stakeholders strengthened	Human resource developed Awareness created on the means of disease transmission & control Knowledge on the disease mgt. improved Stakeholder capacity strengthened	Increased production & productivity Enhanced food and income security of enset farmers

Targets / Zone of Influence

People involved in activities: Two thousand individuals (enset producing farmers, government staff, teachers, partners and other stakeholders) woredas (Lemu, Duna and Misha) through capacity building as well as demonstration and dissemination will be involved in activities to produce outputs:

Direct beneficiaries: People benefiting from development outcome. One hundred thousand enset producing farmers from three woredas (Lemu, Duna and Misha) of Hadiya zone will be benefited from development outcome.

Indirect beneficiaries: People who would benefit from potential impact. Around one million households from Hadiya, Silte Gurage and Kembata zones are potential beneficiaries from this project.

Arrangements Required for Monitoring and Evaluation

- Annual review and joint planning, Monitoring and Evaluation
- Field visit and evaluation
- Reporting
- IP meeting period reports

Communications and Knowledge Management / Transfer

Field day, poster, video, Farm radio (community radio), Publication, Policy (regional and National Level), Partnership development, IP meetings (kebele, woreda, etc), Web site